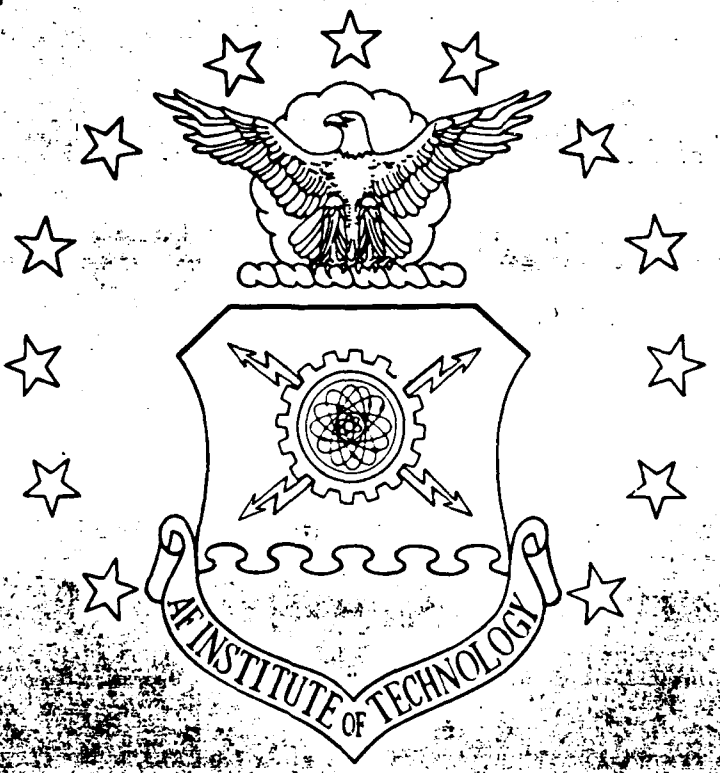

DEPARTMENT OF THE AIR FORCE

AIR UNIVERSITY

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Wright-Patterson Air Force Base, Ohio

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AFIT/GEM/LSM/88S-23

DETERMINING THE EFFECTIVENESS OF THE GRADUATE ENGINEERING MANAGEMENT PROGRAM IN PREPARING CIVIL ENGINEERING OFFICERS

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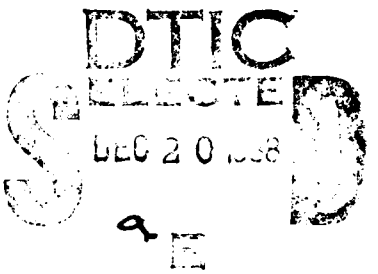

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AFIT/GEM/LSM/88S-23

DETERMINING THE EFFECTIVENESS OF THE GRADUATE ENGINEERING MANAGEMENT PROGRAM IN PREPARING CIVIL ENGINEERING OFFICERS

THESIS

Presented to the Faculty of the School of Systems and Logistics of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Engineering Management

Tracy L. Willcoxon, B.S.M.E

Captain, USAF

September 1988

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Tracy L. Willcoxon

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Abstract

This research study was undertaken to determine how well the Air Force Institute of Technology's (AFIT) Graduate Engineering Management (GEM) program accomplishes its task of preparing civil engineering officers to become effective engineering managers. The primary purpose of this research project was to determine if there was any discernible differences in performance between GEM graduates and non-GEM graduates (civil engineering officers who have received their masters degree by any method other than the GEM program). The secondary objective was to determine if completing the thesis prepares GEM graduates to be better problem solvers.

The data was collected by mailing separate surveys to three groups of active duty Air Force civil engineering officers: 1) those who supervise both a GEM and non-GEM graduate; 2) those who have completed the GEM program; and 3) those who have completed their masters degree by any method other than the GEM program.

The responses to the survey questions were rated on a seven-point Likert scale. Areas of significant difference between the group ratings were examined using the t-test.

Civil engineering supervisors indicated GEM graduates as a group displayed no discernible differences in job performance from non-GEM graduates. Second, supervisors'

assessments of problem solving ability for the GEM graduates were significantly higher than non-GEM graduates.

Fifty-seven percent of the GEM graduates and 52 percent of the non-GEM graduates agree the thesis is <u>not</u> the best method for learning problem solving skills. In addition, 73 percent of the supervisors, 52 percent of the GEM graduates, and 61.7 percent of the non-GEM graduates agree that AFIT should discontinue the thesis or make it optional.

DETERMINING THE EFFECTIVENESS OF THE GRADUATE ENGINEERING MANAGEMENT PROGRAM IN PREPARING CIVIL ENGINEERING OFFICERS

I. Introduction

The purpose of the Graduate Engineering Management (GEM) program is to develop and prepare civil engineering officers to become more effective engineering managers (1). A civil engineering officer carries an Air Force Specialty Code of 55XX. The duties include "design and project preparation, drafting, surveying, planning, feasibility studies, construction surveillance, maintenance and repair, utilities operation, facility energy management, environmental control, land management, real estate and real property accounting, work measurement and analysis, and related installation support services" (6:A15-5). Previous research was conducted to determine which subjects were useful to the GEM graduates (civil engineering officers who have received their master's degree in residence at the Air Force Institute of Technology (AFIT) School of Systems and Logistics in engineering management) and what impact this education had on their career objectives (12). This research examined the perceptions of civil engineering managers to determine if there were any discernible differences in performance between GEM graduates and non-GEM graduates (civil engineering officers who have received

their master's degree by any method other than the GEM program).

The secondary objective was to determine if completing the thesis requirement at AFIT prepared these civil engineering officers to be better problem solvers. The following sections discuss the difficulties an engineer experiences moving from a technical specialty to management, the specific problems of this research effort, research questions this study attempts to answer, and the scope of the research.

Background

Engineers are making the transition from their technical disciplines to technical management very early in their careers. This transition is gaining importance as engineers are confronted with limited resources, constantly changing technologies, and ever increasing demands to improve productivity and keep pace with foreign competition (18:33).

As engineers prepare for this transition, they may realize their technical training was markedly deficient in developing their human-relations and communication skills for the management roles they will assume (18:33).

"To bridge this gap, universities are now offering formal educational programs designed to prepare engineers moving into technical management positions while maintaining their engineering identity" (18:33). "These rigorous

programs blend mathematics, behavioral considerations, organizational concepts, and decision-making methodologies in a delicate balance" (18:33). The demand for engineering management is obvious from the rapid growth of these programs. As indicated in Figure 1, the growth has increased exponentially since the mid-1970's, and there are no signs of it abating (18:33).

In the early 1970's, Air Force Civil Engineering leadership recognized that most civil engineering officers were not properly prepared for management roles in terms of their educational background. Civil engineering officers traditionally were at least minimally qualified in the technical area due to their undergraduate engineering backgrounds. However, many of the jobs faced by civil engineering officers also required skills and knowledge in managerial areas not covered in their undergraduate engineering educations (35:2). Consequently, in 1972 the Air Force Educational Requirements Board identified the need for an Air Force-oriented master's level management program for civil engineering officers. In response to this requirement, the Air Staff directed the Air Force Institute of Technology (AFIT) School of Systems and Logistics to develop a graduate management program for civil engineering officers (21:3-1).

The Graduate Facilities Management (GFM) Program was a 12-month program with 57 quarter hours of graduate work, including a thesis requirement. The first civil engineering

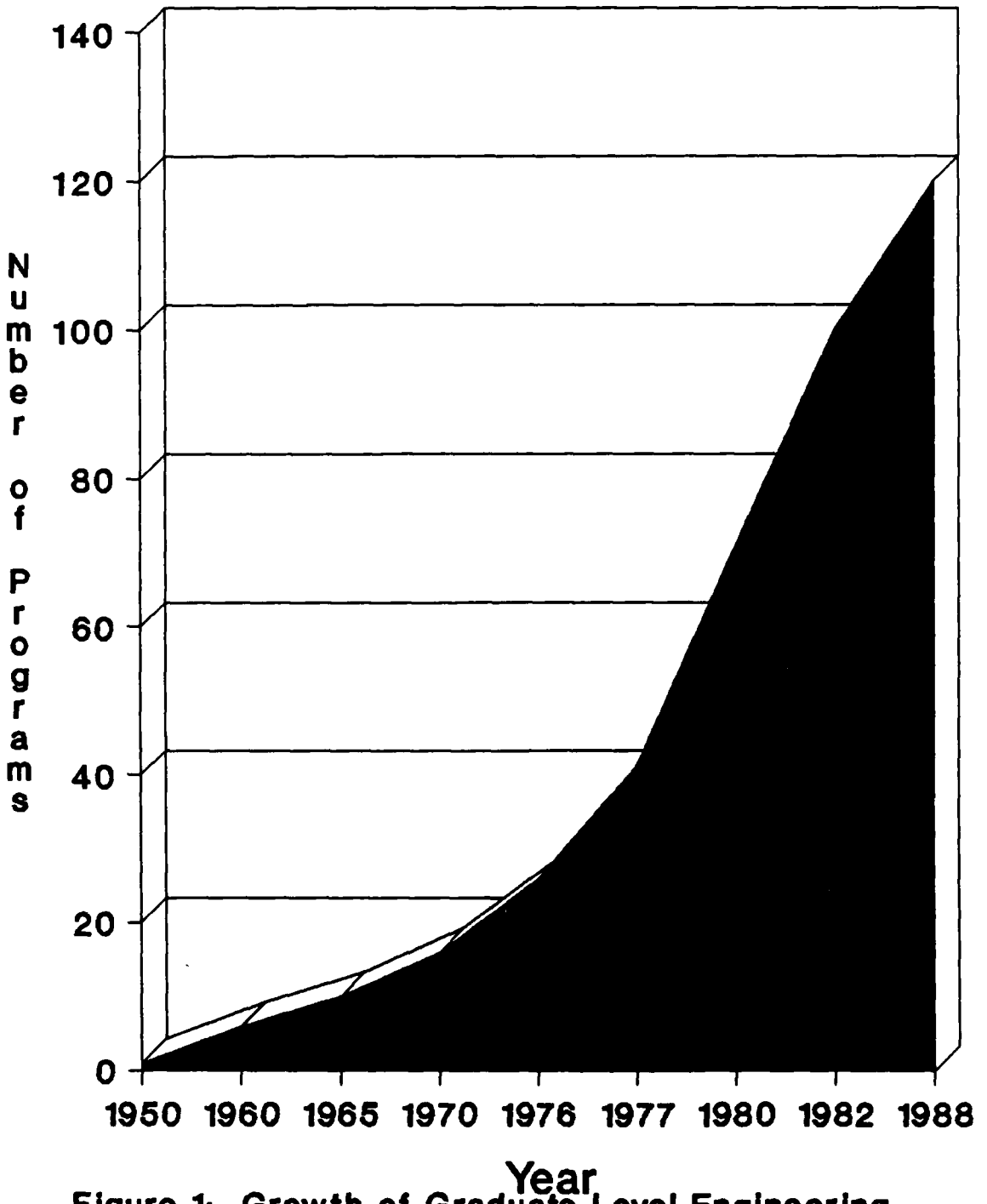

Figure 1: Growth of Graduate Level Engineering Management Programs (5)

students began their GFM studies in January 1973. From 1973 to June 1980, 149 students completed the program and graduated with a master's degree in Facilities Management (41).

In 1980, due to changes approved by the Air Force Engineering and Service Review Committee, the program was extended to 15 months and the name changed to Graduate Engineering Management. In 1982, the program received accreditation by the Accreditation Board for Engineering and Technology (ABET)--the first graduate engineering management program in the United States to receive this recognition (35:2).

Specific Problem

The GEM program was developed to enhance the ability of Air Force civil engineering officers to systematically analyze complex systems and decision situations and to take appropriate management action. The program emphasizes applied quantitative methods, financial management, organizational and behavioral management, computer systems, communication skills, and a research thesis. While the program is built on a foundation of general engineering and management principles, the focus is on facilities and combat engineering in the United States Air Force (1:165).

The objectives of this research effort were twofold: 1) investigate if there were any discernible differences in performance between GEM graduates and non-GEM graduates; and

2) determine if completing the thesis requirement prepares GEM graduates to be better problem solvers.

Investigative Questions

In support of the research objectives, the following questions were developed to measure the effectiveness of the GEM program in preparing civil engineers to be engineering managers.

1. Based on the perceptions of the graduates' supervisors, are there any discernible differences in performance between GEM graduates and non-GEM graduates?

The secondary research objective determines if completing a thesis prepares graduates to be better problem solvers.

1. Based on the perceptions of the graduates' supervisors, are there any differences in problem solving ability between a GEM graduate and a non-GEM graduate?

2. Based on the perceptions of the GEM and non-GEM graduates, is the thesis the best method for learning problem solving skills?

Hypotheses

1. Supervisors' job performance assessments for GEM graduates will not be higher than non-GEM graduates; there will be no significant difference between the two groups.

2. Supervisors' assessments of problem solving ability for GEM graduates will be higher than non-GEM graduates, due to the research methods they acquired at AFIT while completing the thesis.
3. GEM graduates will rate the thesis significantly higher than non-GEM graduates as the best method for learning problem solving techniques.
4. GEM graduates will rate the graduate degree in Engineering Management significantly higher than non-GEM graduates as the most appropriate master's degree for a civil engineering officer.

Scope

As outlined in previous sections, this study relates directly to the basic purpose of the GEM program--to prepare civil engineering officers to become effective engineering managers. GEM graduates who have separated from the Air Force were excluded from this study. This research effort was limited to USAF Civil Engineering organizations within the continental United States due to time constraints. Mailed surveys were used to collect the required data. The results obtained will assist the GEM program manager to assess the impact of the program on the civil engineering career field.

II. Literature Review

Introduction

This chapter expands upon the background material presented in Chapter I. The first section reviews the history of engineering management education and documents the challenges an engineer faces in moving from technical specialty to technical management. The second section provides a historical review of AFIT's Graduate Engineering Management (GEM) program. The third section documents the transition period in graduate schools from the traditional thesis, to the research project, and in some cases to no thesis requirement at all. In the fourth section is a review of two new programs developed by Brian Augarde and Bernard Gordon to fill the management void. Also, in the fourth section, Edward H. Scissons' longitudinal study recognizes the engineer's required technical background is at the expense of his management skills, and possibly hinders his advancement. Scissons also identifies the characteristics engineers typically exhibit.

Engineering Management Education

As noted in Chapter I, many engineers are making the transition from technical specialty to technical management very early in their careers. As a result of this shift, engineering management education has experienced an impressive growth pattern during the past few decades.

According to Dundar F. Kocaoglu, Professor of Engineering Management, University of Portland. The underlying reasons for this growth pattern can be identified at three levels:

> 1. At the national level, challenges to technological leadership, scarcity of raw materials, declining productivity and increased international competition have shifted priorities toward the development of new technologies and the management of technological systems.
> 2. At the industry level, the assumption that "a manager is a manager because he is the boss" has met with strong challenges in the technical environment. The critical importance of engineering skill and knowledge is well-recognized in the management of engineering systems.
> 3. At the individual level, engineers who move to management positions due to their technical success realize their technical skills are inadequate in dealing with the complexities of the management responsibilities thrust upon them. In order to become successful managers, engineers must learn new skills, acquire new values and revise their thinking [18:33-34].2

In order to become successful managers, engineers must learn new skills, acquire new values and re-orient their thinking. The transition from engineering to management requires time for the individual to mature, a progression of on-the-job experiences, and careful career planning (32:249).

A similar career path is followed in Air Force civil engineering. Normally new engineers are assigned to the design section for their first one and one-half to two-years. Based on their performance and position vacancies (personnel transfers) in the squadron, these engineers are assigned to managerial positions requiring greater responsibility. Since Air Force civil engineering is manned primarily with engineers and architects (Table I, Figure 2), they are often not properly prepared for these management

roles, in terms of their educational background. An engineering management master's degree is quite appropriate for civil engineering officers since most of the positions are in management (note the large percentage of officers in the general and staff engineering positions Figure 2).

TABLE I

Air Force Civil Engineering Manning
55XX Career Field Adapted from (3)

Discipline	Authorized	Assigned	Percent
Architect	119	110	92
Civil	299	242	81
Industrial	95	89	94
Electrical	121	117	97
Mechanical	129	122	95
General	740	747	101
Staff-16	502	541	96
Staff-96	17	21	124
Total 55XX	2082	1989	96

In the purely technical fields there is a tendency for the project manager to be an engineering specialist first and a manager second. In the technical role the engineer is forgiven his lack of formal management skills and gains the respect and confidence of team members with superior subject knowledge, experience, and technical judgement. The engineer is readily accepted as the team leader or manager on this basis. When the time comes for the engineer to broaden his horizons, perhaps to satisfy personal ambitions by seeking promotion, lack of management training could be a stumbling block (33:12).

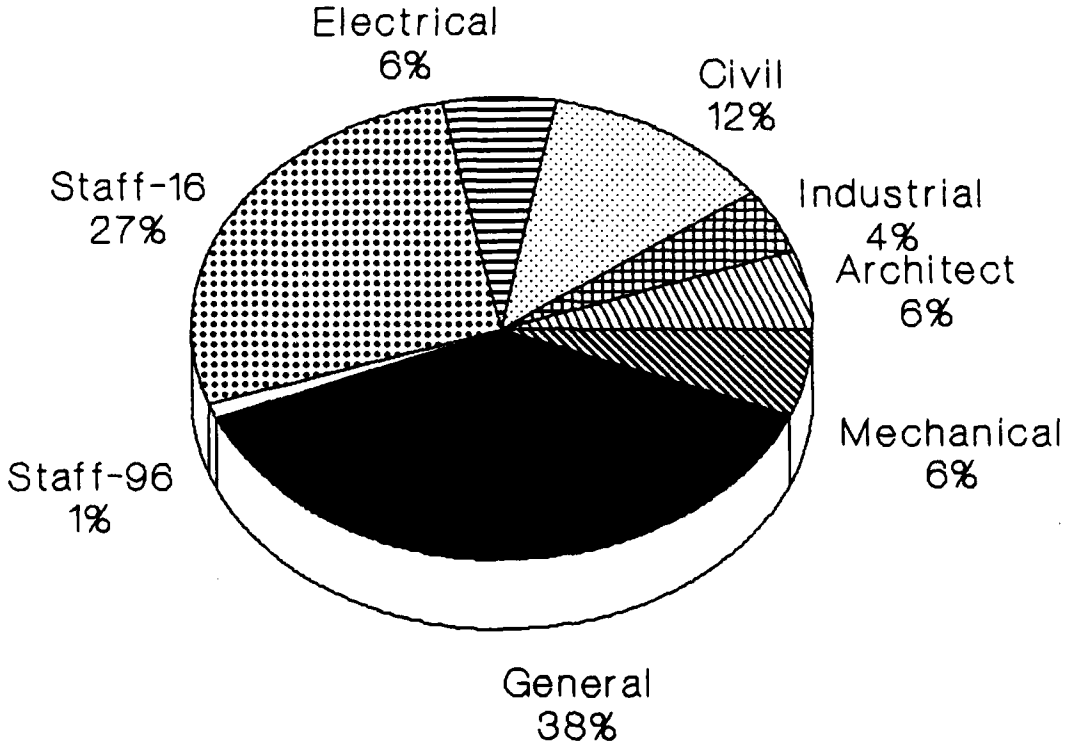

Figure 2: Air Force Civil Engineering Manning (3)

A good example of why management skills are required can be seen in a survey conducted within several technology-based corporations in Pittsburgh, in which 45 percent of the engineers in the 25 to 45 year age group had engineering management responsibility. The positions varied from staff management with indirect supervision to the head of engineering (5:7). In addition, a 1969 report by the Engineering Manpower Commission stated 82 percent of all engineers in the U.S. are involved in management (19:2).

Thus the shift from technical specialist to management begins early in an engineer's career. Typically three to seven years after graduation engineers find themselves making choices between advancing their careers as engineers or moving into engineering management. There are two major factors leading them toward technical management at this point (18:34).

First, by the nature of their profession, engineers are thrust into a management environment by assignment to an engineering project almost immediately upon graduation. In project management an engineer deals with material subsystems, group dynamics among team members, and specialists from other functional groups. In a short time they discover they must work through others, such as draftsmen, designers, and other engineers either directly or indirectly (18:34).

Secondly, the reward system in industry seems to favor individuals moving to management, rather than the technical specialty ladder. The dual-ladder system is based on the

principle that there should be two paths available for advancement in a technical organization, one for those interested in continuing their technical work, and another for those with managerial aspirations. The key to the dual-ladder system is maintaining equivalency between the two ladders (38:45). "Although the dual-ladder concept has been implemented in some industrial organizations, successful implementation is still very limited" (18:34).

Differences between technical and managerial positions in terms of promotional policies can lead to discrepancies. For example, engineers normally have to prove their competence before they are promoted to a higher position. Managers tend to be promoted before they have proved themselves adequate to assume the new job. This leads to the common perception that managers have more responsibility, prestige, and power than engineers. The fact that most engineers are rated by a manager confirms this idea (38:45).

For these reasons, many engineers are learning the techniques of management through various business and management educational programs. Some engineers have entered programs leading to the Master of Business Administration (MBA) degree, while others have pursued graduate degrees in Engineering Management (40:310).

In 1975 John B. Washbush, Assistant Professor of Business Organization and Management at the University of Wisconsin-Platteville, conducted a study to determine why engineers were seeking the MBA degree at Marquette Univer-

sity (40:310). In fact, 25 percent of the students enrolled in the MBA program during the spring semester had undergraduate degrees in engineering. The results of the study are as follow: Engineers were not pursuing the MBA to provide an alternate career direction. They were seeking the MBA degree to broaden their knowledge and improve their management ability and enhance their advancement potential. The respondents to this study agreed that engineers are often not properly prepared academically to understand and appreciate the interactions of engineering with management and business (40:310).

Engineering management programs are distinguished from MBA programs in several ways. The master of science degree in engineering management is designed to provide the engineer with the tools of management. Engineering management programs were developed for technical people and offers them fast pace and mathematical rigor, while MBA programs accept people with either technical or nontechnical backgrounds (28:811).

MBA programs are normally two-years long and emphasize the concepts and theories of management (knowledge) to the virtual exclusion of the practice of managing (skills) and the need to keep technically current. A review of the leading MBA school curricula shows much of the course work deals with the quantitative approach to management, without regard for the qualitative aspects of managing. Generally, course content is directed toward finance, economics,

accounting, organizational development, and marketing. Little attention is focused on managing manufacturing operations, technology, and people (11:110).

The curricula are usually executed through case studies, analytical methods, and theoretical problem solving, with little emphasis on integrating theory and practice into the basic needs of managing. In the days when the future could be predicted from the past, and projections could be made with comfortable degree of accuracy, these approaches may have been acceptable. But that was when the U.S. essentially held all of the competitive cards. The MBA school curriculum today is not directed at the current industry problems of supplying competitive quality products on a global basis (11:111).

The fact that MBA programs fall short does not mean there is no value to the MBA, or that the MBA does not provide some basic understanding and knowledge, or that it cannot advance careers in some cases. But the degree misses the mark of providing the basics of managing in general, and of managing technical professionals in particular (11:112).

In addition, MBA programs usually require engineers to take remedial or leveling courses before formal acceptance into the MBA program. In contrast, graduate engineering management programs are typically one and a half years long, and engineers learn management applications related to engineering (28:811).

MBA programs are well-established in academic communities, while engineering management programs are relatively new. The emphasis on technology in the world economy has increased, resulting in an increased demand for engineering management programs. As of 12 February 1988, 21 universities in the United States offered undergraduate degrees in engineering management (three are accredited: University of Missouri-Rolla, Southern Methodist University and West Point), and 120 institutions offered programs at the graduate level (20). In June 1982, 100 educational institutions--86 in the U.S. and 14 in foreign countries--were identified as offering programs in engineering management (18:37).

In a study presented in 1982 Kocaoglu reports,

> A universal name for engineering management has not yet emerged. But the most common title is "Engineering Management", followed by "Management Option in Industrial Engineering", and "Engineering Administration." With few exceptions, engineering management programs are administered by the School of Engineering, offered either in an existing department, or in a separate academic unit developed specifically for this purpose. When a program is offered in an existing curriculum it is frequently located in the Industrial Engineering (IE) Department. In fact, a number of IE departments are shifting their emphasis toward engineering management and establishing a new identity for their graduate programs [18:37].

Of the 120 engineering management programs in the U.S., 30 are offered within IE departments (20).

When engineering management programs do not fit existing curricula, either an engineering management department is created, or an interdepartmental program is formed that reports directly to the dean of engineering.

In most cases, the programs are under the administrative control of the school of engineering. The students receive their degree from the school of engineering even if some of the courses are offered by other schools in the university. An optional approach is to have a joint offering of the engineering management program by the schools of engineering and business. When this approach is used, the students are admitted into the engineering management program through either school, and all academic policies are administered by a joint committee from the both the schools of engineering and business (18:38).

Most of the engineering management programs offer courses for full and part-time students. The average length for full-time engineering management programs is 17 months in the United States and 16 months in foreign countries. Part-time programs range from 18 to 60 months, with an average length of 37 months in the United States and 31 months in foreign countries (18:39).

The courses offered in engineering management programs range from mathematical modeling to organizational and behavioral concepts to economic decisions to advanced topics in engineering. A master's degree in the US typically requires 30 to 36 semester credits. About 55 percent is taken in core courses and 45 percent as electives. A thesis is required in 28 percent of the programs, not required in 32 percent, and is optional in 40 percent of the engineering management programs. If a thesis is written, it is usually

given 6 semester credits. Most foreign programs require a thesis and the credit awarded for the thesis is approximately equal to the U.S. programs (18:39).

Courses in engineering management programs cover a wide range, including quantitative and qualitative topics, and carefully balance the conceptual and methodological aspects of management. Table II shows the frequency of topics listed as "core courses" in engineering management programs. The most frequently offered core courses are operations research, statistics/mathematics, finance, engineering economy, management theory, group/independent projects, behavioral science/personnel management, project management, engineering, and organization theory (18:41).

The core courses in these 48 engineering management programs indicate six major study areas (Figure 3). A detailed list of the study areas is presented in Table III.

Thus, very early in their careers, engineers must choose either the technical route or the management route. For those choosing management, the only educational alternative in the past was the MBA degree; although it served a purpose it was usually not what engineers were looking for (18:42). "A strong professional identity, a desire to maintain technical orientation, and the uneasy feeling of having to study topics of little interest to them started to steer engineers away from business schools" (18:42).

In response to the engineers' need for a technically oriented management education, universities began to offer

TABLE II

Engineering Management Program Curricula
Adapted from (18) Sample size: 48

Topic (Required Courses)	No. of programs USA
Operations Research	42
Statistics,Mathematics	40
Finance/Engr. Economy	37
Management Theory	29
Decision Theory	22
Group/Independent Project	19
Human Behavior/Personnel Management	18
Project Management	18
Engineering	17
Organization Theory	16
Planning Methodologies	15
Computers	14
Marketing	13
Law	8
Productivity	8
Accounting	7
Strategic Planning Concepts	7
Information Systems	7
Communications	6
Innovation	4
Systems Theory	3
R & D Management	3
Manufacturing	2
Engineering Management Cases	2
Ethics	1
Public Policy	1

the engineering management degree. Engineering management programs were designed for engineers moving toward technical management positions, but not away from their technical backgrounds. These programs increase an engineer's chances for promotion in todays "high tech" environment more than the MBA has done in the past (18:42).

"It is hard to say whether engineering management will

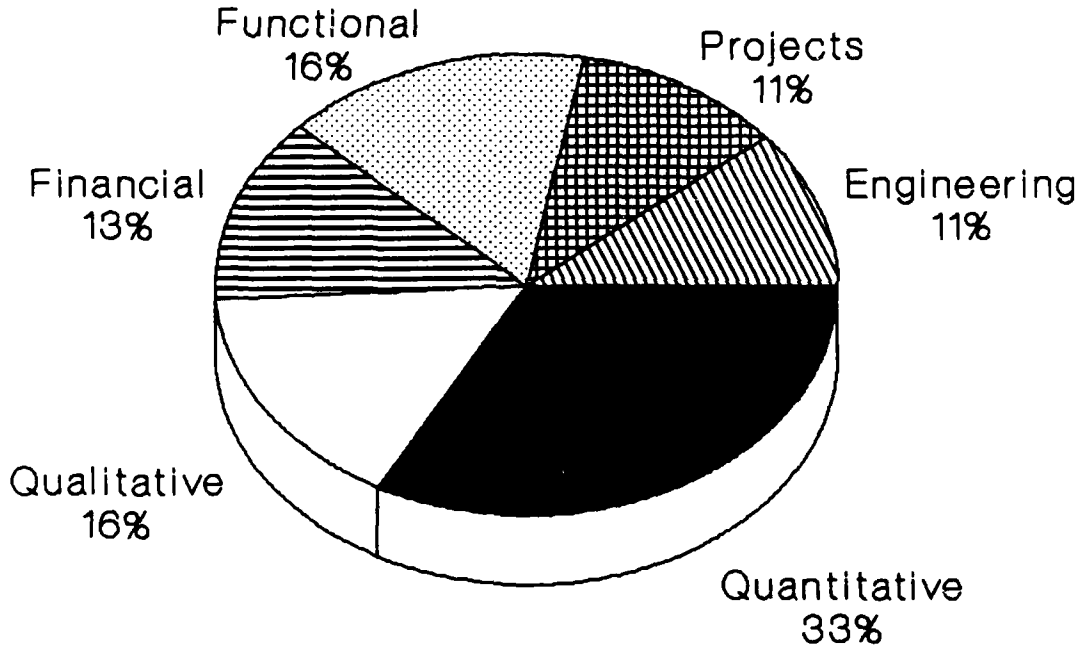

Figure 3: Engineering Management Core Programs in 48 U.S. Programs (18)

TABLE III

Engineering Management Program Structure Adapted from (18). Based on the aggregate summary of core courses in 48 graduate Engineering Management Programs in the U.S.

Study Areas	(%)	(%)
1. Quantitative/Methodological Courses		33
Operations Research	14	
Statistics	11	
Decision Theory	5	
Planning Methodology	3	
2. Qualitative/Conceptual Courses		16
Management Theory	7	
Behavioral Science/Personnel Mgmt.	4	
Organization Theory	3	
Strategic Planning Concepts	1	
Systems Theory/Policy Making	1	
3. Financial Courses		13
Finance/Engineering Economy	1	
Accounting	2	
4. Project Courses		11
Independent/Group Projects	6	
Project Management	5	
5. Engineering Courses		11
6. Functional Courses		16
Computers & Information Systems	5	
Marketing	3	
Productivity	2	
Engineering Law	2	
Communications	1	
Others: Case studies, Manufacturing, Innovation, R&D Management, Ethics	3	

be a separate discipline in engineering, but regardless of what form it takes over the next few decades, it is clear a new field has surfaced and found a niche in extremely fertile ground" (18:43).

History of the AFIT GEM Program

According to the Air Force Institute of Technology catalog:

> AFIT can trace its roots to the early days of powered flight when it was apparent that the progress of military aviation depended upon special education in this new science. In 1919, the Air School of Application was established at McCook Field in Dayton, Ohio, the home of Orville and Wilbur Wright. When Congress authorized creation of the Air Corps in 1926, the school was renamed the Air Corps Engineering School and moved to Wright Field in 1927.
> When the Air Force became a separate service in 1947, the Institute was renamed the Air Force Institute of Technology (AFIT). In 1948, civilian institution programs (sending Air Force personnel to civilian universities) were transferred to AFIT. The Institute established a logistics education program at WPAFB in 1955, and The Ohio State University conducted the first courses on a contract basis. In 1958, AFIT began a series of short courses in logistics as part of the Air Force Logistics Command (AFLC) Education Center. Later that year, the School of Logistics became a permanent part of AFIT.
> In 1954, the 83rd Congress authorized the Commander, Air University, to confer degrees upon persons in the AFIT Resident College. The college was later divided into the School of Engineering, the School of Logistics, and the School of Business. The first undergraduate engineering degrees were granted in 1956, and the first graduate degrees in business in 1958. The School of Business programs were transferred to civilian universities in 1960.
> In 1963, the School of Logistics was redesignated the School of Systems and Logistics. That same year, the Systems and Logistics school began offering graduate degree programs [1:2].

Since 1949, civil engineering officers have attended AFIT graduate education programs at civilian universities. The majority of these slots were technically oriented, resulting in degrees in various engineering disciplines. In addition, since 1955 several different AFIT in residence graduate programs have also educated civil engineering

personnel. As the needs of the Air Force changed, the emphasis of the graduate programs has also shifted (37:8).

In 1971, the Air Force Education Requirements Board identified the need for a master's-level management program for civil engineering personnel. In response to this requirement, AFIT's School of Systems and Logistics developed the 12-month Graduate Facilities Management (GFM) program (37:8).

The GFM program was based primarily on the School of Systems and Logistics graduate logistics management curriculum, with the addition of three new courses and a separately managed thesis. The original GFM curriculum was a 57-hour course of study. In the fall of 1972, final approval was given for the program with a quota of 20 students per year (37:8).

The first seven students began their studies in January 1973; through June 1980, 149 students completed the GFM program (41). Between 1973 and 1980, the curriculum underwent a number of changes to improve the academic quality and relevance of the program (37:8).

The program is evaluated annually by the School of Systems and Logistics graduate faculty and the Air Force Engineering and Services Program Review Committee (PRC). The PRC is comprised of senior air staff and major command Engineering and Services leaders. Because of the program reviews conducted in 1978 and 1979, two problems in the Facilities Management program were identified. First, 12

months was insufficient time to produce a quality thesis in addition to the course work required in the GFM program. Second, the name "Facilities Management" neither correctly described the nature of the program nor was well regarded by the students (37:8).

In the April 1980 meeting of the Civil Engineering Program Review Committee, several changes to the GFM program were proposed. The proposed changes included strengthening the program's technical content, lengthening the program to 15 months, allowing for individually written theses and changing the name of the program to "Graduate Engineering Management". The PRC endorsed the proposed program length and name changes, which were approved by Headquarters Air Force in May 1980. These changes became effective in June 1980 with the enrollment of Class 81S (37:8).

In November 1981 the Accreditation Board for Engineering and Technology (ABET) made an on-site evaluation of the GEM program. The team was impressed with the school's facilities and the quality of academic and professional education. Following their recommendation the Engineering Accreditation Council of ABET awarded accreditation. This was the first graduate level engineering management program to receive this distinction, and currently is the only graduate level program in the U.S. that is accredited (36:28).

In July 1982, the Executive Engineering Management Symposia series was initiated with a speech by Major General

Clifton D. Wright, Director of Civil Engineering. The series includes 10 to 12 presentations by top managers in Air Force Engineering and Services during the 15-month program. This part of the GEM program was instituted to provide students with "an understanding of executive-level management styles, programs, problems and decision-making processes" (36:28) to prepare GEM students for the Air Force civil engineering roles they will assume.

The GEM program, just as the GFM program before it, has undergone several curriculum changes to assure continued academic quality and relevance. The total work load for the 88S program is 72 credit hours (66 graduate, six undergraduate). The current core curriculum is listed in Table IV and the major emphasis areas are shown in Figure 4 (1; 35).

The GEM program also emphasizes thesis research by requiring one core course (COMM 630, Research Methods) and offering an elective designed to provide the student with an opportunity to integrate and augment technical research skills learned in other courses (ORSC 661 Making Sense of Research Data).

Students are scheduled for 12 credit-hours of independent study during their 15 months, devoted to the development of the thesis. Each thesis is prepared under the guidance of at least one AFIT faculty member. The purpose of the thesis is to give students practical research experience. Activities include defining and limiting a

TABLE IV

GEM 88S Curriculum (Adapted from 1:166)

Course Number	Course Title	Credit Hours
	Short Term (4 weeks)	
AMGT 3.35	Financial & Managerial Accounting	2
MATH 2.62	Introduction to AFIT Computer Systems	2
MATH 2.91	Math Review for Engineer Managers	2
	Summer Term	
MATH 5.92	Managerial Statistics I	3
COMM 6.87	Theory & Practice of Professional Comm	3
ELECTIVE	Computer Programming Course	3
ORSC 5.20	Organization and Management Theory	3
	Fall Term	
EMGT 6.16	Engineering Management Information Systems	3
COMM 6.30	Research Methods (Thesis Proposal)	2
ORSC 5.30	Organizational Behavior	3
MATH 6.92	Managerial Statistics II	3
COMM 7.99-01	Independent Study	1
	Winter Term	
EMGT 5.59	Environmental and Energy Issues	4
OPER 5.62	Intro to Management Science	4
COMM 7.99-01	Independent Study	2
ELECTIVE		3
	Spring Term	
CMGT 5.24	Contracting for Engineers	3
EMGT 5.51	Engineering Management Techniques	4
AMGT 6.02	Federal Financial Management	3
ELECTIVE		3
COMM 7.99-01	Independent Study	1
	Short Term (4 weeks)	
COMM 799-01	Independent Study	2
	Summer Term	
EMGT 5.55	Seminar in Engineering Management	3
ELECTIVE		3
COMM 799-11	Independent Thesis Study	6
EMGT 5.56	Executive Engineering Management Symposia	1

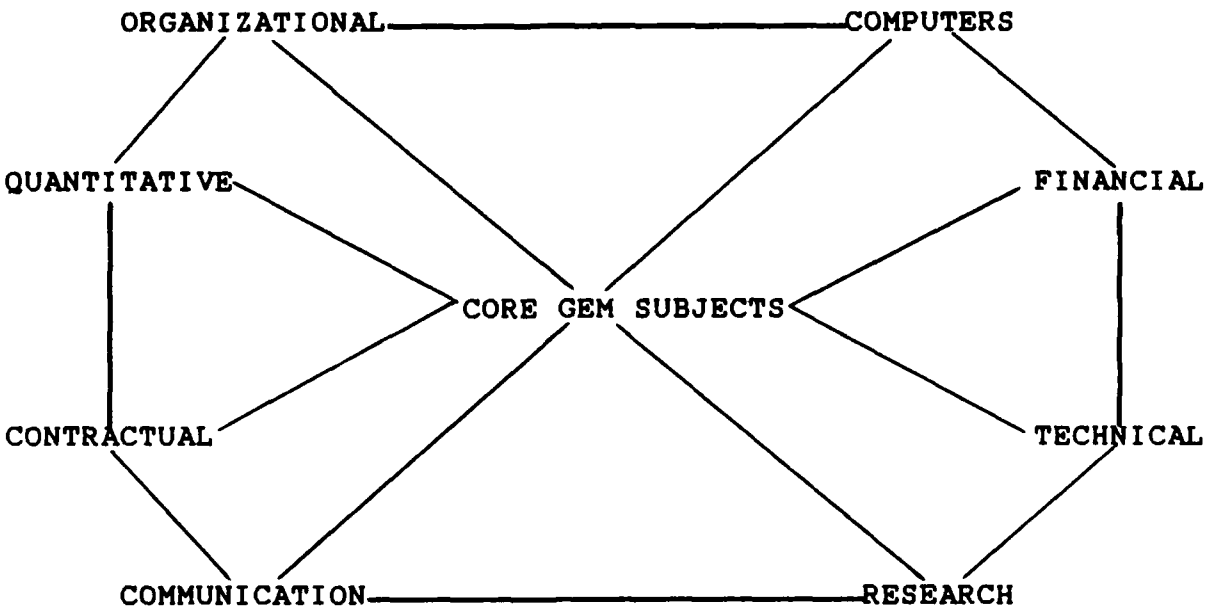

Figure 4: GEM Curriculum: Areas of Emphasis (Adapted from 35)

problem, finding and reviewing pertinent literature, developing an approach to the solution, developing a realistic schedule, and carrying out the steps intended to lead to the solution of the problem (37:9).

Having completed the research, the student prepares a report (thesis) that presents the results of the study to interested parties. Normally topics of the thesis efforts are current Air Force civil engineering problems. Prospective topics are collected annually by the GEM program manager from Major Command Civil Engineering organizations, Air Staff, and the Air Force Engineering and Services Center. Students can also select topics based on their own civil engineering experiences (37:10).

As we have seen in the previous section of this chapter numerous master's-level engineering management programs are being offered across the country to educate technically trained people to manage in technical environments. The GEM program is specifically designed to provide this technically oriented management education. The program is considered part of the total educational development of the engineer by equipping graduates to effectively analyze, design, and manage dynamic and complex engineering organizations (37:8).

The GEM program offers qualified officers a graduate level program designed to enhance their skills, knowledge, and abilities as engineering managers within the civil engineering career field. The GEM program has been recognized for its academic and professional excellence, and only its graduates can claim an ABET accredited MS in engineering management, a prestigious honor for AFIT and the Air Force civil engineering career field (36:29).

As of August 1988, 187 students have graduated from AFIT's Engineering Management program and 23 students (Class 88S) are currently striving to become AFIT GEM's.

Thesis Requirement

The thesis has been a requirement for the master's degree since its inception, and has traditionally made a modest contribution to knowledge, certainly original to the student, and possibly original to the field. "Although the thesis is not now a requirement in many master's programs, a

component demonstrating creativity should be required in quality programs" (17:73).

As noted in the 1984 Kocaoglu study (18), 28 percent of the graduate engineering management programs in the U.S. require a thesis. Currently in the U.S., fewer graduate schools are requiring their students to complete a formal thesis, and many schools are providing alternatives to the thesis. A well-planned and executed thesis can be a satisfying learning experience: it may result in a published article; it could motivate the student to do further research; and it could extend the body of knowledge in the discipline. Too often, however, the experience is frustrating for the students and their adviser. The end product is inadequate, and the student never wants to be involved in research or writing again (42:335).

Graduate students are beginning to resent the formality, lack of flexibility, and lack of innovation in higher education. The thesis, in addition to typifying the formality and rigid requirements of the master's program, also gives rise to many other problems, such as the large time demands on both the student and faculty advisor. With the increasing number of students and the limited number of faculty qualified to chair thesis committees, some faculty members are forced to carry heavy loads (42:335).

The serious faculty shortages in engineering schools were confirmed by a 1985 survey in which 180 schools responded. They reported 1,280 authorized full-time faculty

positions (8.5 percent) were unfilled in the fall of 1985, compared with 7.9 percent in 1983 and 1982 (34:578).

An additional problem students have encountered is in trying to obtain the required data from a sample population in the time allotted to complete the thesis. In addition to, or perhaps because of, the above problems, the thesis requirement itself may produce tension in a student. Students may view the thesis as a barrier to reaching their goals, and become angry with the faculty member who is trying to help them. There are times when a thesis becomes a focal point around which student-faculty and faculty-faculty conflicts are acted out (42:335).

Just as engineering schools are moving from the thesis to the research project or additional course work, the same trend has swept through other graduate programs. For example, the graduate faculty of the College of Nursing and Health at the University of Cincinnati decided to consider whether alternative learning experiences might be substituted for the thesis. They surveyed 34 master's programs in nursing offering projects, studies, or other options to the thesis requirement. They asked the deans to indicate the criteria they used in differentiating between a project and a thesis (42:335).

Twenty-three deans responded to the request; five indicated they allowed no alternatives to the thesis. Two programs did not require either option (thesis or project) for the master's degree. The remaining 17 offered varying

amounts of information about the projects and studies used to fulfill program objectives in relation to research.

Although this study was limited, there were tentative findings: the lack of consensus among master's programs on thesis and non-thesis options was immediately evident. One respondent wrote, "this is a controversial topic at our school--from no requirement at all to a full research project" (42:335). "The guidelines are vague and the terms, project and thesis, are used interchangeably" (42:335). Just as one program had recently discontinued all options to the thesis, another had just switched to a master's project (42:335).

The alternatives to the thesis are offered under a variety of names: research practicums, additional courses, independent study, independent investigation, field study, project, master's essay, master's report, seminar paper, or clinical paper (42:335).

The research practicum differs from other options because it allows the student to work with a skilled researcher who is conducting a study. The student enters the project wherever the researcher is and proceeds from there. Thus, a student might be involved in the data-collection process, review of the literature, tabulation of data, or analysis and interpretation of the data. Students are given credit for this experience, and the school offering this option believes the students learn as much or

more than they would from designing and carrying out a study of their own (42:335).

The Cincinnati survey revealed no clear-cut criteria to distinguish the other non-thesis options from the thesis. Whether the option was the traditional thesis or a research project, clinical paper, master's essay, seminar paper, or master's report, the subject matter and purposes were much the same (42:335).

The primary purpose is to provide a major learning experience in research by allowing students (1) to plan and carry through a systematic study related to their discipline (2) to combine clinical expertise with training in research methodology; and (3) to learn how to communicate thoughts, ideas, and experiences to others. The second purpose is the possible extension of the knowledge pertinent to the student's discipline as a result of the information gained through the research project or thesis. The third purpose is to provide an opportunity for the faculty to evaluate how well curriculum objectives relate to the research accomplished. Several respondents emphasized the learning process, rather than the final product (42:336). A major consideration in evaluation is whether the student's grade should be based on the final product, the process by which it was achieved, or both (42:338).

This study revealed the primary purpose of research in most graduate nursing programs is to learn the methodology of conducting research. The contribution to nursing

knowledge is secondary. The criteria for distinguishing between thesis and non-thesis options deal primarily with differences in process, scope, end product and its utilization, rather than with differences in purposes, appropriate methodology, or subject matter. Some programs have evaluation criteria that deal with the finished product, not with the process the student uses to arrive at the finished product (42:338).

Thus, this survey reveals some programs are dropping alternatives and requiring a thesis, others are dropping the thesis requirement altogether and providing non-thesis options as an alternative. At this time the thesis option appears to be a very fluid issue (42:338).

In another study Kenneth M. Jackson of Indiana University claims, "master's projects at Indiana don't sit on library shelves untouched and collecting dust as theses often do." Two major criticisms of theses are that they do not contribute to the student's professional proficiency, and they do not serve the profession by contributing any useful knowledge. Yet, despite widespread criticism, the graduate committee was reluctant to abandon the thesis. The committee decided students in the professional track of the master's program should plan and execute a major research project, but one that was directed toward a career-related final product. Students in the academic track must complete the traditional thesis, as before (15:19).

The choice of a research project does not create status distinctions among graduate students as some had feared, because professional projects are just as demanding and rigorous as the thesis (15:19).

Beyond the question of the amount of work involved, there is the difficulty of developing an appropriate and acceptable project, since there are special problems connected with professional projects. Because the final product is not standardized in a conventional form, it must be developed by the student and the project committee. This leads to a number of specific problems:

1. The professional skills the student wants to develop are often required (in advance) to complete the project. For example, proficiency in reporting is required for completion of an acceptable product, but the student may only develop such skills during the project. The student's project committee must decide when acceptable performance has been demonstrated.

2. The guidelines and requirements for professional projects are much less detailed and definitive when compared to the thesis. There are shelves of completed theses students can refer to, but no such reference library exist for journalistic projects. Thus both students and their supporting committees often require a great deal of ingenuity, motivation and cooperation to see projects are successfully completed.

3. Partly because of problems suggested in 1 and 2, professional projects often require a great deal more effort, both in planning and production. And much of this work is not directly revealed in the final product. For example, there is no literature review in most professional products, so the student has no easy way of presenting evidence for all material reviewed in the planning stages of the project (15:19-20).

Despite these problems the professional project has become an increasingly popular option at Indiana. Some of the popularity is based on the success of the projects completed--success in terms of developing professional proficiency while creating a product that meets professional standards and serves professional needs (15:20).

According to a survey completed by Michael Singletary and James Crook of the School of Journalism at the University of Tennessee, fewer journalism graduate schools are requiring their MS students to complete a formal thesis, and many schools permitting the professional project in lieu of a thesis are awarding the project less academic credit (31:4).

Many respondents blamed the thesis for the small number of graduates in journalism and mass communication, but a large majority also said the thesis is an opportunity for scholarship that should be retained and not abandoned (31:4).

In the survey they administered, Singletary and Crook found 40 of 43 schools either required or permitted thesis credit toward the master's degree, but only 11 required the thesis, while 31 schools accepted a project in lieu of a thesis. One school required neither thesis, project, nor comprehensive examination (31:4).

At 33 schools, the most common methodologies for thesis research are the mail survey, historical research, content analysis, and telephone survey. These research methods present problems because the skills and training required of these methods are often not the ones--or at least not perceived by the students as the ones--that contribute most to professional practice. Job-minded students often resist because they do not see themselves doing these things in their work (31:5).

Journalism master's degree programs are in a period of transition from the traditional thesis to a professional project, yet many schools cling to the thesis by offering it as an option. The schools adopting the professional project in lieu of the thesis usually award it less academic credit and less status than the thesis (31:6).

With regard to the thesis, according to the Manual of Graduate Study in Engineering,

> it is only at the doctorate level that there is justification for the requirement that a thesis shall comprise an original contribution to knowledge as evidence of expertise acquired. In respect to the thesis for a master's degree, the time conventionally assigned is limited and the student is usually inexperienced in research. It should be clear, therefore, the objectives of the master's thesis are not the same as those of the

> doctorate. A commonly accepted principle in the curriculum leading to a master's degree in engineering is that the master's thesis should train the candidate how to conduct research rather than expect the thesis to make a contribution to the field of knowledge.
>
> In 1983, 196 U.S. institutions reported they offered master's degrees in engineering, 150 of them with non-thesis options. In most cases where explicit information was given, the non-thesis options include a requirement for a report or a project. In a few cases it was explicitly stated that no thesis, and presumably no project, was required. Stanford University, the nation's largest producer of engineering master's degrees (753 master's degrees in 1982-1983) and one of the nation's most respected graduate schools, specifically states a thesis is not required for a master's degree.
>
> Those who favor the elimination of the thesis as a requirement for the master's degree feel there are too many master's theses each year to provide adequate supervision, particularly if there is a heavy load of doctoral theses. Hence, there is concern whether the master's thesis requirement properly fulfills its role to provide a challenging, creative experience for the student. On the other hand, there are many who feel the master's thesis is an important "capstone" requirement, and it provides a major opportunity for a graduate student to undertake a project activity under their own initiative [17:73-74].

A significant, well-supervised master's thesis project clearly has value for the student, but the value declines if the thesis is allowed, under the press of other business, to deteriorate into a routine exercise. The thesis or creative design project need not represent an original contribution to the field, but it should be original with the student. It should represent a meaningful, creative experience from the student's point of view (17:74, 82).

The same trend has developed in engineering management, with few students selecting the thesis option. At the University of Pittsburgh three students in the master's

level engineering management program have completed a thesis in the last 11 years, out of 600 graduates. Typically the students use the thesis to gather useful information in preparation for their doctoral work. The three students who completed the thesis option at the University of Pittsburgh continued in the PhD program; thus, preparing to write a dissertation was the motivation behind their choice. Since most engineering management programs are oriented for the working professional, the research required of the master's thesis, without carrying it to the next higher level, is not attractive to the student (20).

Based on the observations of Dr. Yildirim Omurtag, Chairman of the Engineering Management Department, University of Missouri-Rolla, the young graduate with a BS in engineering (Mechanical, Electrical, Civil, Chemical) and a MS in engineering management with thesis option seems to have an easier time during recruitment. The recruiter is impressed with the thesis experience and this gives the student something to talk about with the recruiter that the non-thesis student does not have (24).

The young student with an MS in engineering management with thesis option is more sought after by industry than the non-thesis student. The value the employer sees in the thesis is not the research, but the thesis reflects the student's ability to learn, finish a project, and get closure. For an experienced engineer coming back for a master's degree in engineering management, completing a

thesis is not important; that is not what the student or their employer is looking for (24).

Since the engineering management program began in 1967 only five percent of the MS students at the University of Missouri-Rolla have completed a thesis. The emphasis was not on research. The program was a terminal degree to serve working engineers and develop their management skills in the shortest time possible to help them do their jobs better and enhance their promotion potential; therefore, the thesis was not even considered. But since instituting the PhD program in 1981, the engineering management department has redirected the on-campus program to emphasize research. The department now stresses research at the undergraduate level, and will emphasize the thesis at the MS level. Currently the thesis is not required, but will be highly encouraged beginning next year (24).

While this plan is easy to execute on-campus with young students, it is not possible in the university's satellite programs at St. Louis and Fort Leonard Wood. This is a different group of students; they are practicing engineers who want to develop their management skills in the shortest time period. The MS degree in engineering management is the perfect answer. Since 1967 only one or two students have completed a thesis at a satellite program. Dr. Omurtag does not foresee this trend changing (24).

Since AFIT does not have a PhD program in engineering management, the GEM program is a terminal degree. The

students are practicing engineers, so the thesis will not enhance their marketability. Since most of the GEM students are not industrial engineers, they have little management education and the extra time gained by dropping the thesis option could be used to broaden the students backgrounds in other managerial areas (24).

According to Dr. Omurtag, "From what I have seen of AFIT's Graduate Engineering Management Program it is an excellent program, but I believe AFIT is pushing the thesis without a realistic appreciation of the demands on the students. You cannot produce a quality thesis with the extensive course work required" (24).

Review of Related Research

Industry and business recognize the difficulties engineers experience when they transition to management; this attitude is reflected in numerous journal articles: "Engineer to Manager--the Challenging Transition" (33), "Engineer to Manager--a Difficult Transition" (25), "Crossing Over from Engineering to Management" (39), "The Dual Ladder of Advancement" (38), "Who Says an Engineer Can't be #1" (8), "Easing the Managerial Transition for Engineers" (13), and "Moving from Technical Specialty to Technical Management" (18).

Engineers who become managers confront a fundamental change in the nature of their work; they move from performing specific technical tasks to directing others to

perform these tasks. According to James Owens of the American University School of Business, "the engineering manager must give up his familiar technical function and delegate this work to subordinates" (25:12). He continues, "managers who fail to let go of technical responsibilities tend to neglect their managerial functions - staffing, scheduling, project planning - to the detriment of their subordinates" (25:12).

The engineer's job shifts from technical to conceptual and human relations as he climbs the executive ladder. Engineers who hold on to the technical functions tend to be autocratic in running their sections. Although this is the most accepted style in industry today, it has serious drawbacks.

> The autocratic style erodes morale and motivation among professional workers who take pride in their own creativity, ambition, and ability to work independently. Given the expansion of technology, the average manager lacks the depth of information needed to make sound decisions without consulting their subordinate who probably know more about specific technologies than they do. The contingency theory of leadership allows the manager to be the faciliatator, establishes & maintains goals, but does not issue short-term directives on how to achieve these goals. Good management shares the job, allowing every worker to contribute in the decision process at their level. The facilitator or manager is the informal leader of the cooperative team, holding the authority organizational position but rarely exercising it. [25:12]

One new approach to provide engineers with the necessary skills to be effective managers was developed by Brian Augarde and Dr. Michael Skipton of Kingston Polytechnical in England. They developed a four-year course, Master

of Engineering (M Eng), aimed at turning out the senior managers of the future (10:26). Both Skipton and Augarde are angry that engineering and management are seen as two separate disciplines and they hope to improve the balance. Skipton states, "What is so special about management that non-technical people can do it, but it is assumed from the start that engineers cannot" (10:26)? The Kingston course follows the views forwarded by the Engineering Council in its education policy statement in 1983. It suggested two types of courses, M Eng and Bachelor of Engineering (B Eng). All students start on the B Eng then, after one year, the premier students are pulled into the M Eng course. During the four years, students are also exposed to the business and commercial aspects of engineering. The school's objective with the new M Eng program is not to turn out circuit designers, but managers. About 75 students start on a combined M Eng/B Eng course and in 15 months those with the potential are selected for the M Eng course. Selection of the 12 to 20 students for the M Eng is based on personal qualities. Augarde believes the essentials for future managers are the ability to communicate effectively through inventiveness, initiative, and competitiveness (10:26).

According to Skipton, "A problem with engineers is their lack of assertiveness. Every engineer must recognize himself as a business professional, and these graduates will have the confidence to say I am an engineer and a manager" (10:26).

Another new approach to engineering management has been developed by one of America's most successful engineer-entrepreneurs, Bernard Gordon, who is launching a new master's degree program designed to produce engineers ready and willing to lead; it has been called the West Point for Engineers. Gordon's company receives approximately 2,000 job applications from engineers every month. Yet in the course of a year he sees fewer than three of four people who have what it takes to run a project or a design team (22:68).

Most companies do not hire engineers to be leaders. Instead, companies encourage the engineer to concentrate in narrow specialties. This environment does not produce inventive, productive, and cost-effective project engineers.

> According to Gordon, Engineering schools must bear the blame too; they teach about things, not people. They concentrate on specifics, not fundamentals, they teach facts, while paying little attention to attitude. Many engineers are coming out of school with a very narrow background in mathematics and physics. They lack the ability to take a subject they know very little about, study it, learn from history--and finally put it all together in an invention. Engineering students are being led to believe research and the academic world are more prestigious callings than working in industry [22:68-69].

The Gordon Institute (located in Wakefield, Maryland) plans to achieve a sense of balance; they want to broaden the exposure of the student to literature and the humanities, both as a character building influence and as a means to improve writing and oral communications skills (22:69).

Another block of the curriculum will focus on engineering leadership and the economics of product development. Students must design a product for their firm during their year at the institute. The project must be of commercial value to their company (22:69).

The students must have a minimum of three years engineering experience, so the age range is roughly 25 to 34. Tuition is $15,000, which is paid by the student's company. The students' companies also continue to pay salary and benefits, along with housing and other living expenses.

According to Gordon, "We have received a tremendous amount of interest from many colleges" (22:69). "In fact, the dean of the engineering school at MIT, Gerald Wilson, is one of the institute's trustees" (22:69). "As for industry, I don't have enough time to meet all the requests from companies to speak on the subject" (22:69).

Characteristics of Engineers

In 1979, Edward H. Scissons, Associate Professor, University of Saskatchewan, conducted a study of 196 Canadian engineers with a comparable sample of Canadian business managers. The study indicated there were similarities in leadership drive, assertiveness, achievement orientation and enterprise between the two groups, but there were significant differences as well. Compared to other business managers, the engineer was less versatile, with a restricted range of interests, less patient and less

respecting of the opinions of others, unlikely to engage in emotional problem solving, demonstrating low interpersonal insight, lower verbal fluency, and restricted self-control (30:166).

The major difference seems to be one of orientation and style of dealing with people. The engineers treat people on the basis of how reason dictates they should be treated; the business managers, on the basis of how they need to be treated. It is this inability to perceive a situation from another person's perspective that distinguishes the engineer from the other groups (29:824-825).

If these are the characteristics that best distinguish the engineers from their business manager counterparts, which characteristics best distinguish between the junior and senior engineers? The differences indicate senior engineers present themselves as less driven to succeed, less tactful or tolerant, more conforming to established procedures, but less persistent in attacking problems. The difference between the profiles of the junior and senior engineers is obviously one of degree. Unfortunately, however, if you are to compare these personality characteristics with other people managers, the junior engineer would be a better supervisor than the senior engineer. The differences between the two groups are small, and junior engineers in this sample also lack effective interpersonal skills needed for management (29:825).

Based on the information gained from his sample, Scissons sees engineers as uniquely suited to the technical tasks required by their jobs but less well suited for the interpersonal/people-handling aspects of the profession. Engineers as a group possess enviable skills in many areas, but are unusually deficient in others (29:826).

Based on his 1979 study Scissons wanted to investigate or cross-validate his first study by revisiting the engineer, in this 1984 study of 379 Canadian engineers. These engineers were employed by private Canadian corporations, mainly in central or western Canada. Mean age of the sample was 35; mean length of time since completing an undergraduate engineering degree was 12 years. Of the sample, 65 (17 percent) possessed an advanced degree, either a master's or doctorate in a particular branch of their discipline or an M.B.A. (30:165).

This 1984 study (30) was intended to answer two specific research questions, one leading directly from the earlier research, the other not dealt with by previous studies:

1) First, are there differences in the assessed abilities of Canadian engineers based on length of tenure as an engineer?

2) Second, are there differences between the assessed abilities of Canadian engineers who have completed a basic engineering degree and those who have completed a graduate degree in addition to the basic requirements?

Although enhanced in several areas, the results from this study generally confirmed the findings from the 1979 study.

In terms of the senior versus junior dimension, it is not surprising that junior engineers present themselves as more intelligent or capable of enhanced learning. It is possible that with increasing competition for university entrance, the intellectual caliber of recent engineering graduates may actually have improved over the years (30:168).

The interpersonal dimension is not so easily explained in the junior/senior sample. Although senior engineers show some enhancement in this area since the earlier study, junior engineers are still stronger in knowledge of effective interpersonal behavior in business situations, perhaps best described as "business manners." Although still lower than executives generally, the junior group outperforms their senior counterparts (30:168).

The engineers with only an undergraduate engineering degree present themselves as more intelligent and verbally facile, with enhanced practical judgment, personal poise, task completion drive, and practical judgment in "people" areas. Engineers in the advanced-degree group present themselves as somewhat more objective, with higher needs for autonomy and independence, less enduring but with higher achievement needs, and more aggressive and dominant. In short, the advanced group seems to want more, but the basic

group has higher levels of those characteristics associated with actually achieving more (30:168).

In summary, engineers continue to give evidence of a unique perspective in the business environment. On the one hand, they are disposed--both by preference and training--to a technical orientation in solving problems. On the other hand, it becomes increasingly difficult to effect technical excellence without, at the same time, having a high level of non-technical skills. Improvement in the non-technical areas would seem to make good engineers better--even in the technical areas (30:168).

Chapter Summary

The first section of this chapter includes a brief history of engineering management education, and notes the challenges an engineer must overcome to become an effective manager. As a group, engineers believe that moving into management will bring them higher salaries and higher levels of responsibility than continuing in their technical disciplines. Thus engineering management education has been one of the most popular methods engineers have used to meet these challenges. With the shift in emphasis from engineering to management, engineering management education programs have experienced tremendous growth over the past two decades. The history and development of the AFIT GEM program was presented to show the commitment and responsive-

ness of the Air Force in preparing civil engineering officers for their future roles as managers.

The third section documented the transition period in graduate education (non-engineering degrees to engineering programs) from the traditional thesis to the research project. Two of the major criticisms of theses are they do not contribute to the student's professional proficiency, and they do not serve the profession by contributing any useful knowledge.

The last section reviewed two new programs developed by Brian Augarde and Bernard Gordon to educate engineering managers for tomorrow's senior leadership roles. Also related studies conducted by Edward H. Scissons were presented in which he documents the characteristics that distinguish engineers form their business manager counterparts. These studies document management shortfalls in an engineer's education, and conclude most engineers require training prior to assuming management positions.

The Air Force, like many employers, pays the educational costs to prepare their employees, and improve their job performance. Thus, the GEM program offers a unique opportunity for engineers to enhance their skills, knowledge, and abilities as engineering managers in the Air Force civil engineering career field. Engineering management educational programs are on the rise nationally, and the GEM program certainly stands among the leaders in quality education.

III. Methodology

Introduction

The main purpose of this research project was to determine if there were any discernible differences in performance between GEM graduates and non-GEM graduates. The secondary research objective was to determine if completing the thesis prepares GEM graduates to be better problem solvers. This chapter describes the methodology used to accomplish the research objectives, answer the research questions, and evaluate the hypotheses listed in Chapter I.

Emory (9) proposes a four-level hierarchial sequence of questions to guide the research process.

> The first level is the management question which represents a decision the manager must make and is the problem prompting the research. Information needs grow out of the management question leading to the second level, the research question, which reflects the main purpose of the research.
>
> Once the general research question has been defined, the research moves to the third level--investigative questions. These are the specific questions which the researcher must answer to satisfy the research objectives. They guide the details of the research effort, including the development of concepts, operational definitions, and measurement devices. Measurement questions constitute the fourth level; these are the questions respondents answer in the surveys [9:20-22].

In this research study, the GEM program manager is tasked with managing the GEM program, whose purpose is to prepare civil engineering officers to be more effective engineering managers. A natural management question

follows: Does the GEM program prepare the graduates to perform better, and does completing the thesis make them better problem solvers than their peers?

Classification and analysis of the information gained through the measurement questions in the survey provides answers to the research questions, satisfies the research objectives and ultimately provides the required information allowing the program manager to answer the management question (9:41).

Included in this chapter is a discussion of the surveys used to collect the data, the populations and samples from which the data were collected, procedures used to process the data, and the computer programs and statistical tests used to analyze the data.

The Surveys

Supervisor's Survey. The supervisor's survey consisted of a 53-question, 10-page questionnaire and a cover letter (Appendix B). The cover letter explained the purpose of the survey, explained how the results would be used, and assured the respondents their anonymity would be maintained.

The survey contained five parts. Part I contained six multiple choice background questions to obtain demographic information about the respondents. The last three questions were open-ended questions.

Part II contained 15 questions assessing the GEM graduate's job performance in comparison with all civil

engineering officers of equivalent rank and time in the 55XX career field. Part III consisted of seven questions relating to the GEM graduate's problem solving ability. Parts IV and V were identical to parts II and III, but directed toward the non-GEM graduate.

The ability to quantify the responses in part II through part V were important to answer the proposed research questions and research hypotheses. The seven-point Likert scale was used for measurement (9:255), as in the following sample:

Rate this officer compared to his/her peers using the following scale to select your response.

Accomplishes any task assigned with minimal guidance.

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

The Likert scale allowed measurement of the respondents level of agreement to each of the questions in part II through part V. Eighty-six surveys were mailed on 8 April 1988, requesting the supervisor to return the survey 10 days after receipt.

GEM and Non-GEM Surveys. The GEM and non-GEM surveys contained 24 and 21 questions respectively. They were divided into three parts (Appendix C and D). Part I contained multiple choice questions about backgrounds and pertinent demographic information. Part II contained general questions asking the respondents to evaluate the graduate programs they attended. Part III incorporated open-ended questions to obtain the respondents' beliefs on the following: the most appropriate MS degree for a CE officer, the best method of teaching students how to do research, and the best way to prepare CE officers to be effective managers.

The survey instruments used in this study were aided by a previous research effort completed by Halsey and Hooper (12). The resulting surveys had the validity gained from the earlier study, as well as validation by experts in the field of engineering management and research survey development (12, 27, 14).

Population and Sample

Survey participants were selected from three target populations of active duty Air Force civil engineering officers: 1) those who supervise a GEM and non-GEM graduate; 2) those who have completed the GEM program; and 3) those who have completed their master's degree by any method other than the GEM program.

The purpose of the sampling plan was to allow the supervisor to assess the graduates' job performance and problem solving ability in comparison with their peers. This provided sufficient data for the researcher to determine if significant differences existed between the two groups.

Determining the Sample Size. First, some basic statistical terms will be clarified to aid the following discussion. In testing statistical hypothesis, the problem will be formulated so one of the claims is initially favored. This initially favored claim will not be rejected in favor of the alternative claim unless sample evidence contradicts it and provides strong support for the alternative assertion. The claim initially favored or believed to be true is called the null hypothesis and is denoted by H_o. The other claim in a hypothesis testing problem is called the alternative hypothesis and is denoted by H_A (7:278).

A type I error consists of rejecting the null hypothesis (H_o) when it is true. A type II error involves not rejecting (accepting) H_o when H_o is false. Since Beta is the probability of making a type II error (failing to reject a false hypothesis H_o then it follows that 1-Beta (Power) must be the probability of correctly rejecting the false hypothesis (16:185). Now that the basic statistical terms have been introduced the next logical question is, how is power calculated?

Determining the power of a particular statistical test requires the values of four factors influencing Beta: 1) how far the true mean deviates from the hypothesized mean; 2) the significance level (alpha), and whether the test is one-tailed or two-tailed (power increases as alpha increases); 3) standard deviation of the sampled population; and 4) sample size "n" (power increases as "n" increases). The four parameters are so related that when any three of them are fixed, the fourth is completely determined (4:153).

When drawing a sample from a population in order to test a hypothesis about a particular population parameter, it is important to have a powerful test. But of the factors that influence the power of a test, only two are under the researcher's control--"n" and alpha, which are chosen to evaluate H_o. Since there is concurrent concern about committing a type I error, this restricts the variation of alpha, leaving "n" as the only variable to increase the power of the test (16:189).

Calculating the power of a test requires: 1) the true value of the parameter; 2) the population standard deviation (sigma); 3) alpha; and 4) "n". It is easy to turn the problem around and ask what "n" would be required to have a test of: a) desired power when b) the true population parameter value is a given value, for c) a given value of the population standard deviation (sigma) and for d) the desired alpha (16:190).

The sample size for the supervisors was determined by pre-testing the supervisor's survey; of the eight surveys administered, four were returned. For overall job effectiveness mu_1=6.0 (mean), $sigma_1$=0.8165 (standard deviation) and mu_2=6.0, $sigma_2$=0 for the GEM and non-GEM respectively. For problem solving ability mu_1=5.5, $sigma_1$=0.57735 and mu_2=6.25, $sigma_2$=0.5 for the GEM and non-GEM respectively.

The sample size was then determined by the method described above. An alpha of .05 was selected. The data obtained from the pretest surveys were entered in a Power-pack program (Appendix A) using the two sample t-test (26). By iterating "n" Figures 5 and 6 were obtained. Then, plotting sample size "n" versus power of test allows the sample size to be selected based on the power of test desired by the researcher.

An expected return rate for an AFIT graduate research survey is approximately 50 percent (27). Thus with a 50 percent return rate, one could reasonably expect 43 returned supervisor surveys. Forty-three returned surveys would result in a 95 and 88 percent probability of correctly rejecting a false hypothesis of the job effectiveness and problem solving ability between the graduates, respectfully.

After defining the three target populations the decision was made to only survey officers stationed in the continental U.S. (CONUS) to ease the data collection process. After completing an Air Force military personnel center ATLAS database search, 149 GEM graduates stationed in

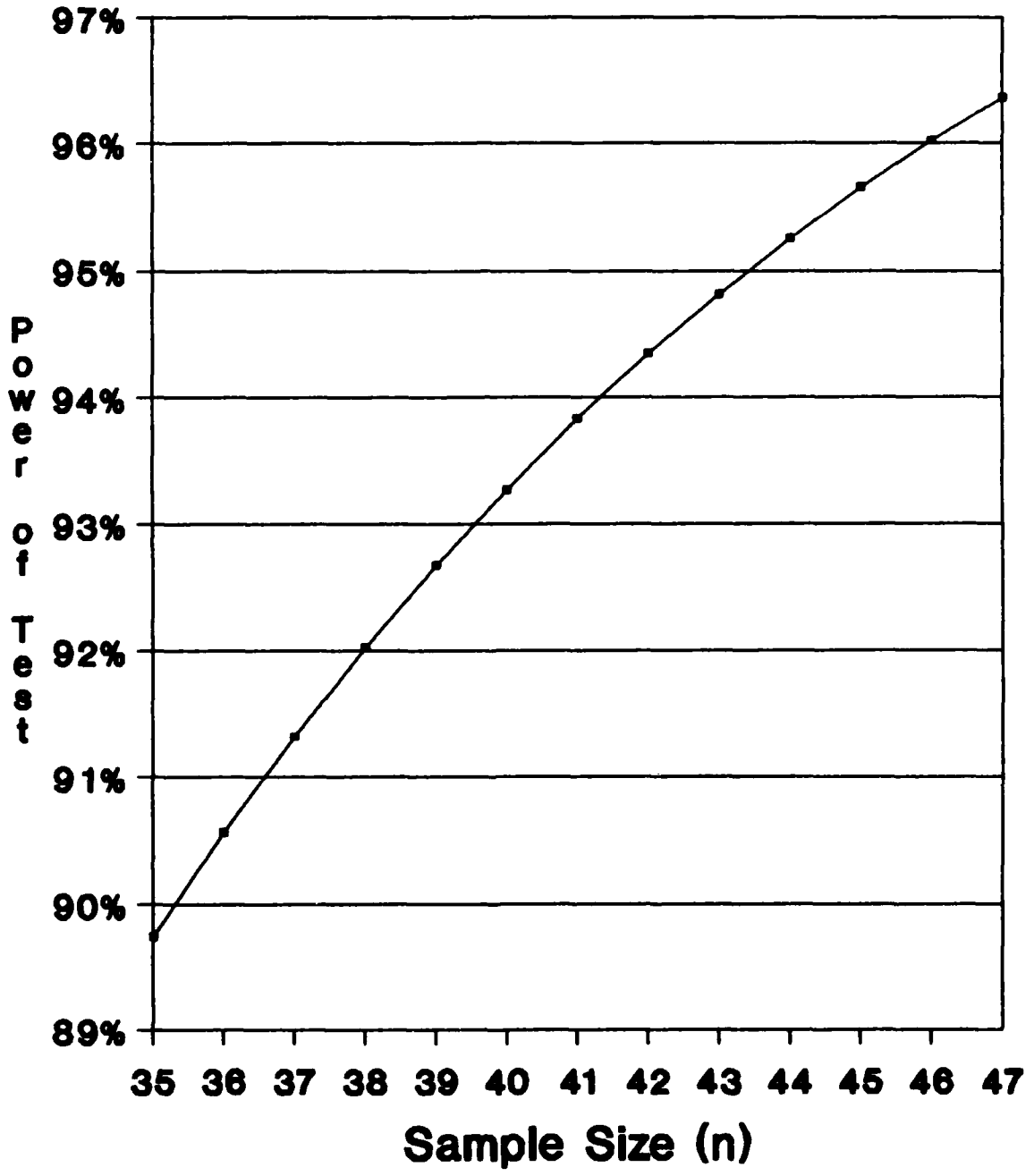

Figure 5: Overall Job Effectiveness - Power of the Test

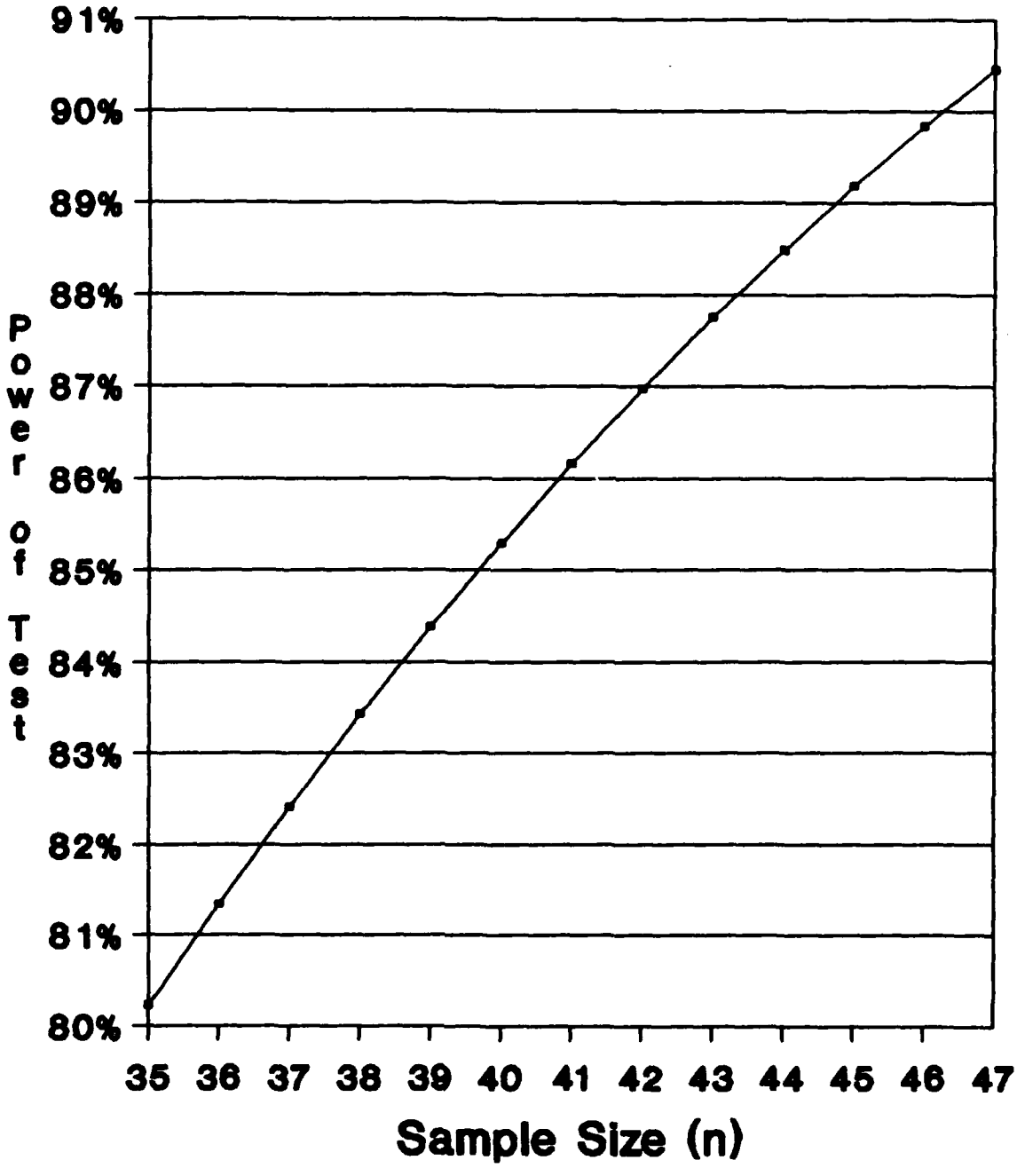

Figure 6: Problem Solving Ability - Power of the Test

the CONUS were identified. Matching non-GEM civil engineering officers with these 149 GEM graduates who had the same supervisor resulted in 86 matches.

The second survey (GEM survey) was mailed to 149 GEM graduates, and the third survey (non-GEM survey) was mailed to 86 of the matched non-GEM's plus 63 randomly selected officers to match the 149 GEM.

Data Collection

In this study the objective was to determine if there is any appreciable difference in job performance and problem solving ability between GEM and non-GEM graduates. The best method for evaluating these individuals would be to have the same supervisor rank them before attending AFIT and after graduation, to determine if there is any significant difference in performance. But, officers are not assigned to the same units, and supervisors also move, making this process virtually impossible.

Another method would be to evaluate the GEM graduates officer evaluation reports (OER) before and after completion of the GEM program to determine if there is any significant difference in job performance and problem solving ability. However, gaining access to OER's is a difficult and time consuming process which could not be completed in the allotted time period.

Due to these reasons, a matched randomized-group design was used. Both groups are approximately equal in education

and experience, with the only difference being the treatment--the GEM program, with the non-GEM's serving as the control group.

After considering several data collection techniques, it was determined a mailed questionnaire would best satisfy the needs of this research effort. Personal interviewing was disregarded due to time and economic constraints. Telephone interviewing was not selected due to time requirements for such large samples. Because mail surveys cost less to conduct, can cover wide geographical areas, and offer anonymity, it was selected as the best data collection technique. The most important advantage was anonymity, which should encourage the respondents to answer each question honestly. There are some disadvantages of using a mail survey, of which non-response is the most important (9:172).

Measures

Appraising Job Performance. Appraising performance is one of the most problematic areas in management. No matter whether the organization is large or small the performance of its members must be evaluated to make decisions on wage and salary levels, promotion decisions, terminations, and to determine training needs (2:102).

The results of performance appraisals are vital for the effective operation of other human resources management programs. For example, a merit pay or bonus system would

have little credibility if appraisal results were not actually used as the basis for these awards. Likewise, the appraisal system would have little credibility if the results were not seen by people in the organization as influencing such decisions as merit pay. Thus, the decision for management is not whether to appraise performance, but how to do it (2:103).

Assessing job performance is composed of two processes, observation and judgment, both of which are subject to bias. For this reason, some have suggested that job performance be judged solely on the basis of objective indexes such as production data and personnel data (accidents, awards). While such data are appealing, these objective indexes often do not measure performance, but factors beyond an individual's control. In addition, these objective indexes do not measure behavior, but instead the results of behavior (4:73).

Because of these deficiencies, subjective criteria (e.g., supervisory ratings) are often used. However, since ratings depend on human judgement, these indexes are subject to other kinds of biases (errors).

Raters may make certain types of errors in their ratings. They may rate all ratees too high or too low (leniency and severity error). Supervisors may avoid using the high and low extremes of rating scales and tend to cluster all ratings about an average rating (central tendency error). Supervisors may base their rating on one

key trait or aspect of job performance, rather than rating all of the important aspects of performance separately (halo error). For example, because a ratee is often tardy, they are rated low overall, even if performance is good when at work (2:107). Due to these possible rater errors, this study had one supervisor rate two individuals to help reduce these inter-rater biases.

Some of the methods (peer assessment, appraisal by subordinates, and self-appraisal) used for rating job performance attempt to reduce bias in some way, although no method is completely bias-free (4:73).

Bias can be reduced sharply, however, through training in both the technical and the human aspects of the rating process. Some research has found the most effective performance assessment programs allow ratee participation in the development of the criteria. This participation helps to gain ratees' commitment to the goals of the program and helps them to become aware of the rater's problems (2:105).

Due to these reasons, this study used the mailed survey which allowed supervisors extra time to consider choices and make responses that accurately reflected their views while maintaining their anonymity.

Data Analysis

Hypothesis Testing. The purpose of hypothesis testing is to help draw conclusions about population parameters based on the results observed in a random sample. The

procedure remains virtually the same for tests of most hypothesis.

* The favored or believed hypothesis H_o and its alternative H_A are formulated.
* A test statistic is chosen to evaluate H_o.
* The test statistic is calculated, for the sample.
* If the observed significance level is judged small enough, the null hypothesis is rejected (23:83).

This study included the following hypotheses (groups 1 and 2 refer to GEM and non-GEM graduates, respectively):

Hypothesis number one:

H_o: $mu_1=mu_2$ Supervisors believe there is no difference in work performance between GEM and non-GEM graduates.

H_A: $mu_1 \neq mu_2$ Supervisors believe there is a difference in work performance between GEM and non-GEM graduates.

Hypothesis number two:

H_o: $mu_1 \neq mu_2$ Supervisors believe GEM graduates are better problem solvers than non-GEM graduates.

H_A: $mu_1=mu_2$ Supervisors believe there is no difference in problem solving ability between GEM and non-GEM graduates.

Hypothesis number three:

H_o: $mu_1 \neq mu_2$ GEM and non-GEM graduates will disagree that the thesis is the best method for learning problem solving techniques.

H_A: $mu_1=mu_2$ GEM and non-GEM graduates will agree that the thesis is the best method for learning problem solving techniques.

Hypothesis number four:

H_o: $mu_1 \neq mu_2$ GEM and non-GEM graduates will not agree that a graduate degree in engineering management is the most appropriate master's degree for a civil engineering officer.

H_A: $mu_1 = mu_2$ GEM and non-GEM graduates will agree that a graduate degree in engineering management is the most appropriate master's degree for a civil engineering officer.

Analysis

All statistical methods used for this research were accomplished using the Statistical Package for the Social Sciences (SPSS^x), release 10. Copies of all programs used in the statistical analyses are contained in Appendix E.

The analysis was performed to help answer the research questions posed in Chapter I. The main statistical techniques used to address these questions were frequency analyses, descriptive statistics, and the paired t-test. The paired t-test was used to determine if GEM graduates differ significantly in performance and problem solving abilities from non-GEM graduates based on the supervisors responses. The two sample independent t-test was also used to determine if there were significant differences between the GEM and non-GEM responses. The results of the data analysis described in this chapter are presented and discussed in Chapter IV.

IV. Results

Introduction

This chapter contains an analysis and discussion of the data obtained using the methodology described in Chapter III. The supervisors' survey results are presented, followed by the GEM and non-GEM survey results. The respondent's demographic information is presented first followed by the t-test comparisons. Finally, the statistical test results are summarized in terms of the research questions.

Supervisor Survey Results

Eighty-six surveys were mailed to civil engineering officers who supervise both a GEM and a non-GEM graduate. Forty-one supervisors responded, for a 54-percent response rate, after subtracting 5 surveys for incorrect matches, 4 PCS moves, and 1 retirement. Forty-one returned surveys set the power of the test for job effectiveness (Figure 5) and problem solving ability (Figure 6) at 94 and 86 percent, respectively.

The response rate could be attributed to the opinions expressed by the Deputy Chiefs of Staff (DCS) at the Program Committee Review (PRC) held at the School of Civil Engineering and Services at Wright Patterson AFB, 12 April 88. The DCS's at this meeting stated that too many behaviorally-oriented surveys were being conducted in the GEM program and different types of research should be done. The DCS's

suggested future GEM students should pursue research directly related to current civil engineering needs (42). Shortly after this meeting, they received the surveys for this study, so the response rate could be a reflection of the attitude expressed at this PRC meeting.

Demographic Results. Based on the demographics (Table X - Table XV, Appendix F) the average supervisor was a male (100 percent) colonel or lieutenant colonel (82.9 percent) with more than 11 years of managerial experience in civil engineering (73.2 percent) who had supervised one or more GEM graduates (73.2 percent). He probably completed his master's degree at a civilian university (46.3 percent) possibly on his own time (29.3 percent). He either completed a thesis (39 percent) or selected the non-thesis option (24.4 percent) and believes his job requires a master's degree to do it correctly (70.7 percent).

Reliability Analysis. The reliability of a measure refers to its trustworthiness. It expresses the repeatability, stability, or consistency of the measure. The reliability coefficient, which is typically obtained through use of the correlation coefficient, indicates the consistency of the obtained scores (2:282). Inter-question reliability analysis was conducted (using coefficient alpha, which reflects the degree of homogeneity within the measure) to test the consistency of the scores on the job performance and problem solving ability questions in both the GEM and non-GEM surveys. The results displayed in Table V indicate

non-GEM surveys. The results displayed in Table V indicate that the performance and problem solving ability questions had a high degree of reliability.

TABLE V

Survey Question Reliability - GEM and non-GEM

Variable	Coefficient Alpha	
	GEM	NON-GEM
Job Performance	.9385	.9651
Problem Solving Ability	.8919	.9499

T-Test Comparisons. The paired t-test was used to determine if the differences between the GEM and non-GEM graduates were significantly different for each of the 22 measurement questions in the supervisors survey (Appendix B). Questions 10 to 31 pertained to the GEM graduates and questions 32 to 53 referred to the non-GEM graduates. The supervisors rated the GEM graduates significantly higher on five questions, as indicated in Figures 7 and 8 on the following two pages. Exact values are listed in Table XVI, Appendix F.

Supervisors rated GEM graduates as a group significantly higher than non-GEM graduates in their ability to use systems modeling in the decision process. Supervisors also

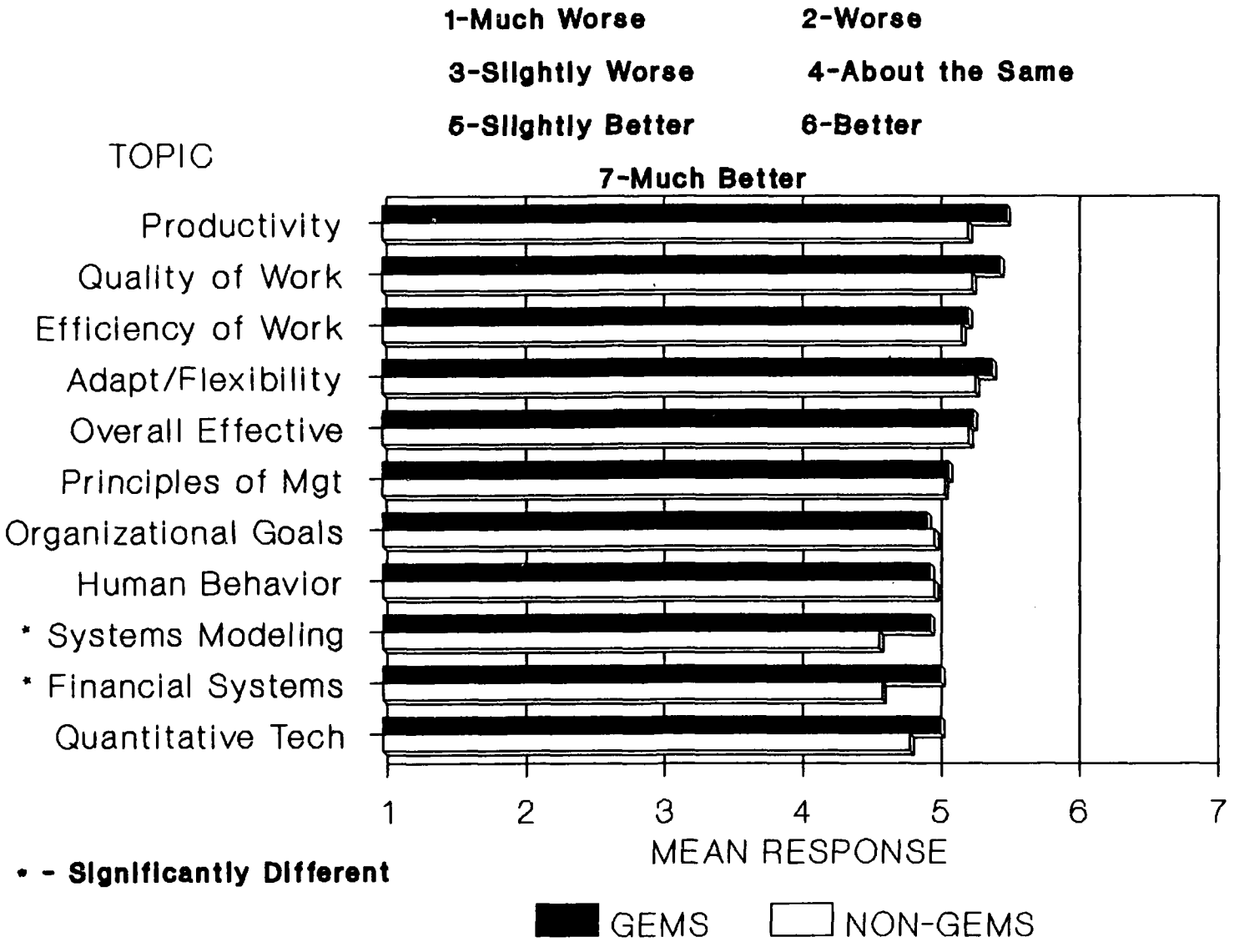

Figure 7: T-Test Results Between GEM and Non-GEM Graduates

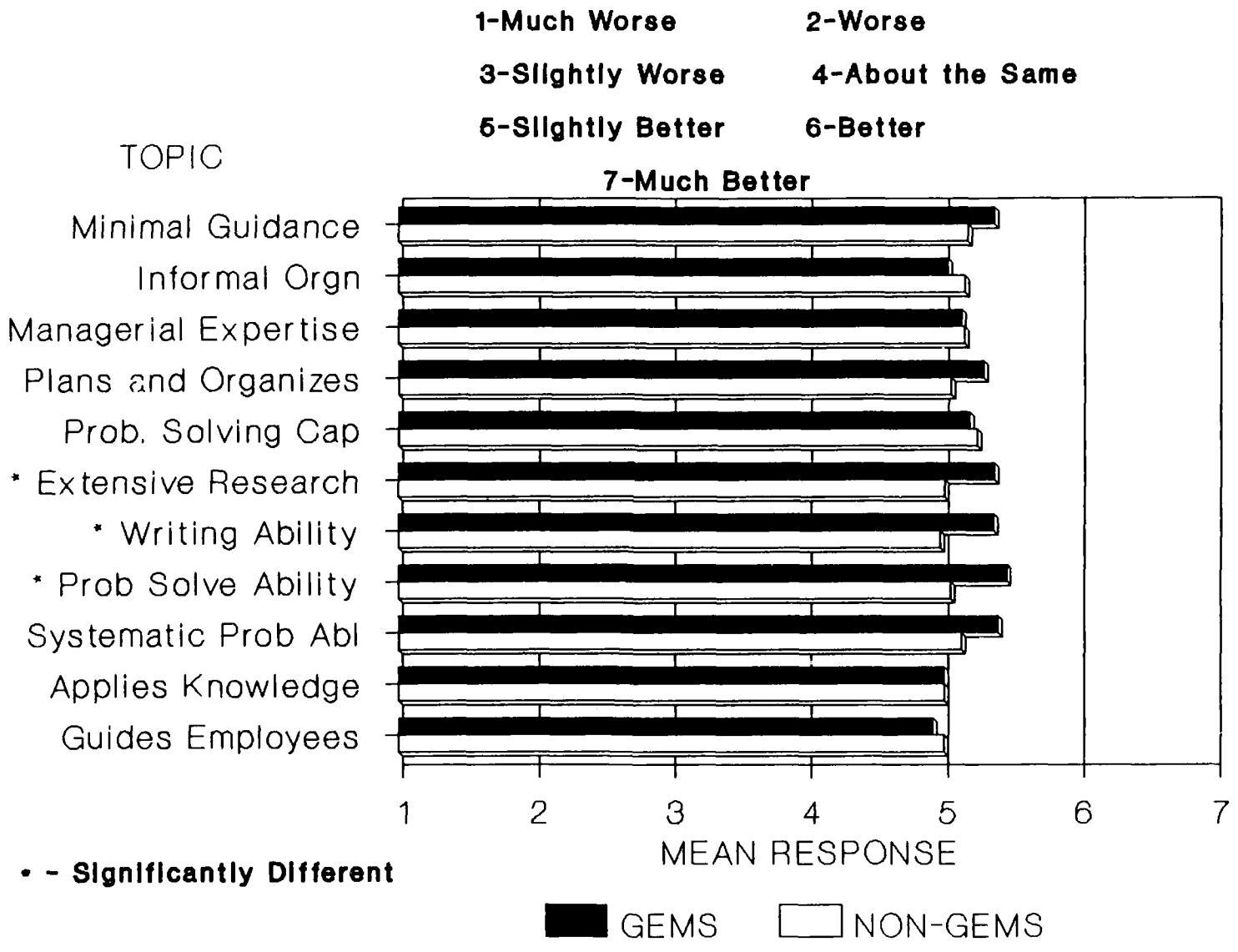

Figure 8: T-Test Results Between GEM and Non-GEM Graduates

indicated GEM graduates as a group are significantly more adept at applying these techniques in the decision making process. In fact, this was the most significant difference observed in the comparison tests between the two groups.

Supervisors indicated GEM graduates as a group have a significantly better understanding of the financial system used by the federal government. Supervisors also indicated GEM graduates perform significantly better than non-GEM graduates on projects requiring extensive research.

Supervisors noted a significant difference in the writing ability of the two groups. The supervisors rated GEM graduates significantly higher than non-GEM graduates. The last area in which the groups showed a significant difference was in problem solving ability; supervisors rated GEM graduates significantly higher than non-GEM graduates.

The differences in job performance and problem solving ability were tested by creating a job performance composite question and a problem solving ability composite question. An equally weighted average of questions 10-14, 21, 22, and 24 made up the job performance composite question for the GEM graduates. The composite question for the non-GEM graduates used the identical questions in the non-GEM section of the survey, questions 32-36, 43, 44, and 46. The composite problem solving question used questions 25, 26, and 28-30; and questions 47, 48, and 50-52 for the GEM and non-GEM graduates, respectively. The statistical results of the t-tests appear in Table VI, and indicate there is no

significant differences in the mean responses between GEM and non-GEM graduates for the composite questions.

TABLE VI

Composite Question Analysis

	GEMS	NON-GEMS		
Composite Variable	M	M	t	p
1. Job Performance	42.24	41.47	.51	.610
2. Problem Solving Ability	26.50	25.56	.99	.325

Tests of Hypotheses

Hypothesis 1. Supervisors' job performance assessments for GEM and non-GEM graduates will not be significantly different. The difference in the means for job performance between GEM graduates and non-GEM graduates were not statistically significant. Thus the results support this hypothesis.

Hypothesis 2. Supervisors' assessments of problem solving ability for GEM graduates will be significantly higher than non-GEM graduates. The mean responses for performance on a project requiring extensive research and

problem solving ability for GEM graduates were significantly higher. Based on these results, the data support the hypothesis.

GEM and Non-GEM Survey Results

The GEM survey was mailed to 149 graduates; 108 responses were received for a 73 percent response rate. The non-GEM survey was mailed to 149 non-GEM graduates; 94 individuals responded for a 63 percent response rate. In all the results presented, the first number refers to the GEM graduate and the second to the non-GEM graduate, unless indicated otherwise.

Demographic Results. Based on the demographics (Table XIX - Table XXV, Appendix G) there was no typical GEM or non-GEM graduate. The respondents displayed a diversified background, with only these predominate characteristics: a male (96.3 and 92.6 percent) captain (58.3 and 50 percent) with an undergraduate degree in civil engineering (64.8 and 48.9 percent).

Age distribution varied, with the largest percentages (36.1 and 37.2) in the over 37 category. Just as age varied, the years of managerial experience in civil engineering varied, with 70.2 percent of the respondents indicating they had under 10 years of experience.

Table VII shows the method non-GEM graduates used to obtain their master's degree. The majority of the respondents indicate they obtained their MS on their own time

(54.3 percent). This is nearly twice the percentage of the supervisors (Table XII, Appendix F).

TABLE VII

Method Master's Degree Was Obtained (non-GEM)

METHOD	FREQUENCY	PERCENT
ON MY OWN	50	54.3
AFIT-CI	35	37.2
AFIT IN RESIDENCE	1	1.1
AFIT PART TIME	0	0.0
OTHER	6	6.4
MISSING	2	2.1
TOTAL	94	100.0

It is evident that since the GFM program began in 1973, fewer civil engineering officers have been sent to civilian universities. In addition, AFIT's fairly stringent entrance requirements have forced many officers to complete the master's degree on their own, which is confirmed by these results. It is this researcher's opinion that AFIT's reputation of being a challenging school has lead many civil engineering officers to seek other alternatives.

Table XXVI (Appendix G) lists the mean responses for the survey questions for both the GEM and non-GEM graduates. Figure 9, on the following page, displays the results of the

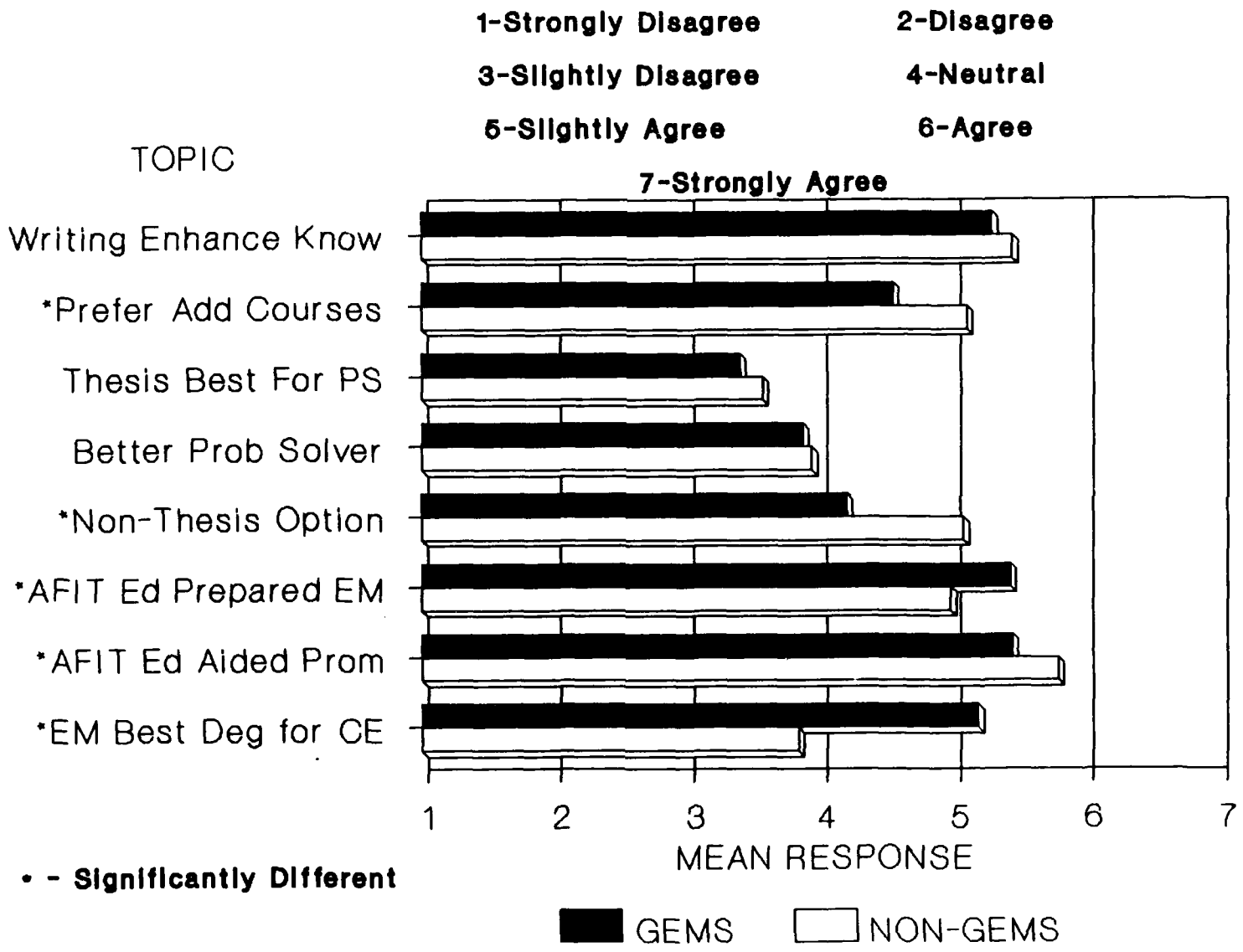

Figure 9: Independent T-Test Between GEMs and Non-GEMs

mean responses for the eight matching questions on the GEM and non-GEM surveys. Figure 10, on the next page, displays the remaining GEM and non-GEM graduates' responses.

GEM Responses. GEM graduates indicated they highly recommend the GEM program to other civil engineering officers; in fact, this item received the highest rating (Figure 10). Next, GEM graduates suggested their AFIT education has enhanced their promotion potential (Figure 9). The GEM graduates also concur that completing the AFIT program had prepared them to become more effective engineering managers. The GEM graduates agree that writing papers for courses enhanced the knowledge of course material and related subject areas. Question 18 was the last question the GEM graduates ranked above 5.0, indicating their agreement that a graduate degree in engineering management is the most appropriate master's degree for a civil engineering officer.

As shown in Figure 9, the GEM graduates slightly agreed they would have preferred taking additional course work and completing a research project in lieu of the thesis. The GEM graduates were neutral that AFIT should adopt a non-thesis option like other engineering management programs.

As shown in Tables VIII and IX, most of the GEM graduates indicated the workload in the program was about right (58.3 percent), although 26.9 percent thought it was a little heavy. The majority of the GEM graduates also indicated the length of the program was about right (64.8);

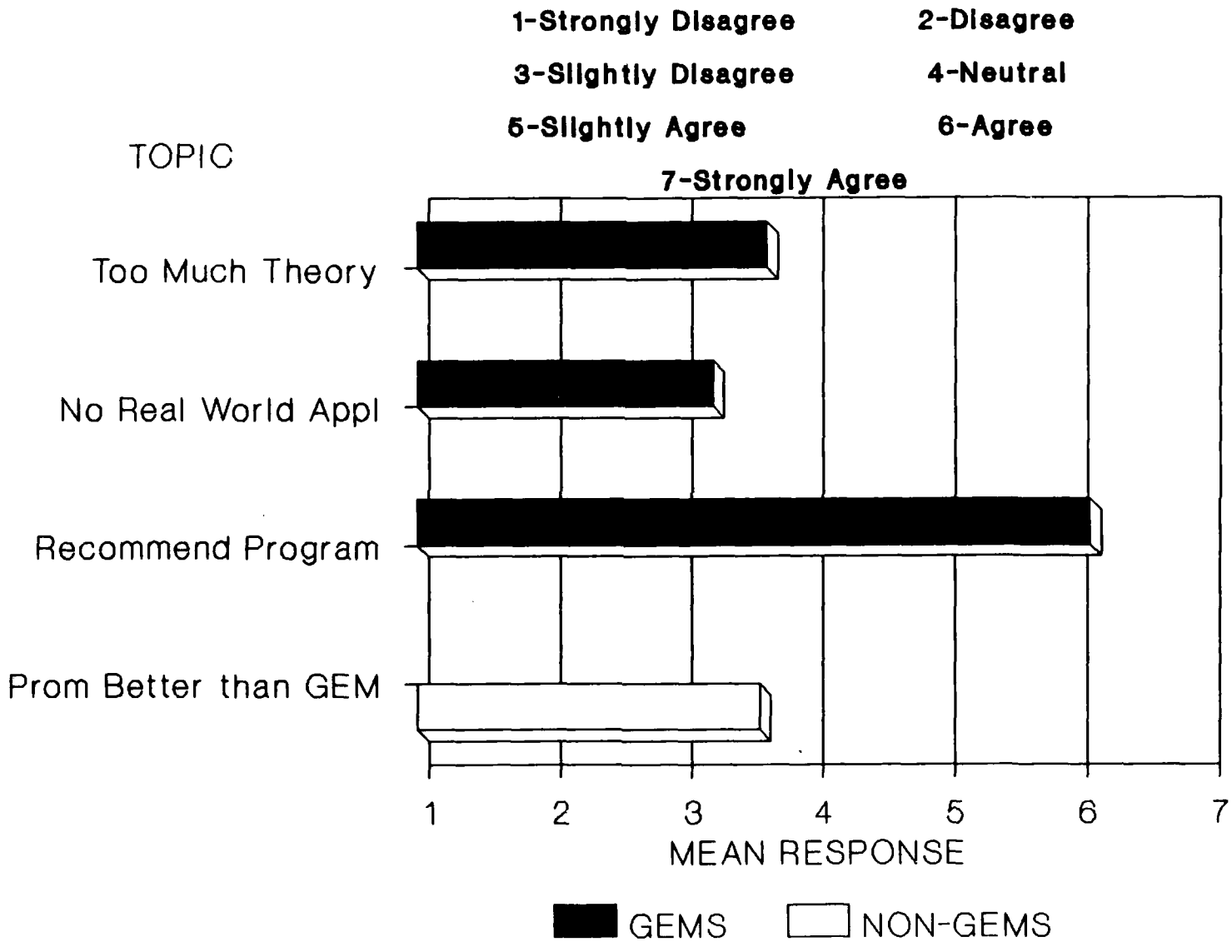

Figure 10: Additional GEM and Non-GEM Responses

21.3 percent indicated it was too short. This was undoubtedly due to the (12-month) GFM graduates' responses.

TABLE VIII

Responses to GEM Program Workload: Question 19

RESPONSE	FREQUENCY	PERCENT
TOO LIGHT	1	.9
A LITTLE LIGHT	6	5.6
ABOUT RIGHT	63	58.3
A LITTLE HEAVY	29	26.9
TOO HEAVY	6	5.6
MUCH TOO HEAVY	3	2.8
TOTAL	108	100.0

TABLE IX

Responses to GEM Program Length: Question 20

RESPONSE	FREQUENCY	PERCENT
TOO LONG	1	.9
A LITTLE LONG	4	3.7
ABOUT RIGHT	70	64.8
A LITTLE SHORT	23	21.3
TOO SHORT	8	7.4
TOO SHORT	1	.9
MISSING VALUE	1	.9
TOTAL	108	100.0

As shown in Figure 10, the GEM graduates indicated that the courses were not too theoretical and related directly to their jobs.

Non-GEM Responses. As shown in Figure 9, the non-GEM graduates agreed that obtaining a MS degree enhanced their promotion potential; in fact, this topic received the highest rating. The non-GEM graduates as a group agreed that writing papers amplified what they learned in school. In contrast to the GEM graduates, the non-GEM graduates would have preferred taking additional courses and completing a smaller research project rather than the thesis. They agreed that AFIT should adopt a non-thesis option similar to many other engineering management programs. The non-GEM graduates also agreed that their graduate education had prepared them to perform more effectively as engineering managers.

The non-GEM graduates were neutral whether the thesis made them better problem solvers. They were nearly neutral (mean response 3.8) that a MS degree in engineering management was the most appropriate graduate degree for a civil engineering officer. The non-GEM graduates indicated they were between neutral and disagreeing slightly that the thesis was the best method of learning problem solving techniques.

Although they believe their chances for promotion are enhanced with the graduate degree, they do not believe their chances are better than a GEM graduate, shown in Figure 10.

T-Test Comparisons. The independent, two sample t-test was used to determine if the differences between means were significantly different for the eight matching questions in the GEM and non-GEM surveys. The results are shown in Figure 9 and Table XXVI. When asked if writing papers for courses enhanced their knowledge of course material and related subject areas, the non-GEM graduates rated this question higher than GEM graduates, but not significantly.

As shown in Figure 9, the non-GEM graduates rated taking additional courses and completing a research project, instead of the thesis, significantly higher than GEM graduates. As shown in Figure 11 and Table XXVIII Appendix G, 59.3 percent of the GEM graduates indicated they slightly to strongly agreed that they would have preferred taking additional courses and completing a smaller research project instead of the thesis; 64.8 percent of the non-GEM graduates slightly to strongly agreed.

As shown in Figure 9, both groups are in complete agreement that the thesis is not necessarily the best method for learning problem solving techniques, with the non-GEM graduates rating the thesis slightly higher, but not significantly different. These findings were confirmed by the frequency responses in Figure 12 and Table XXIX in Appendix G, in which 57.3 and 51.9 percent of the GEM and non-GEM graduates respectively indicated they strongly to slightly disagree that the thesis is the best method for learning problem solving skills.

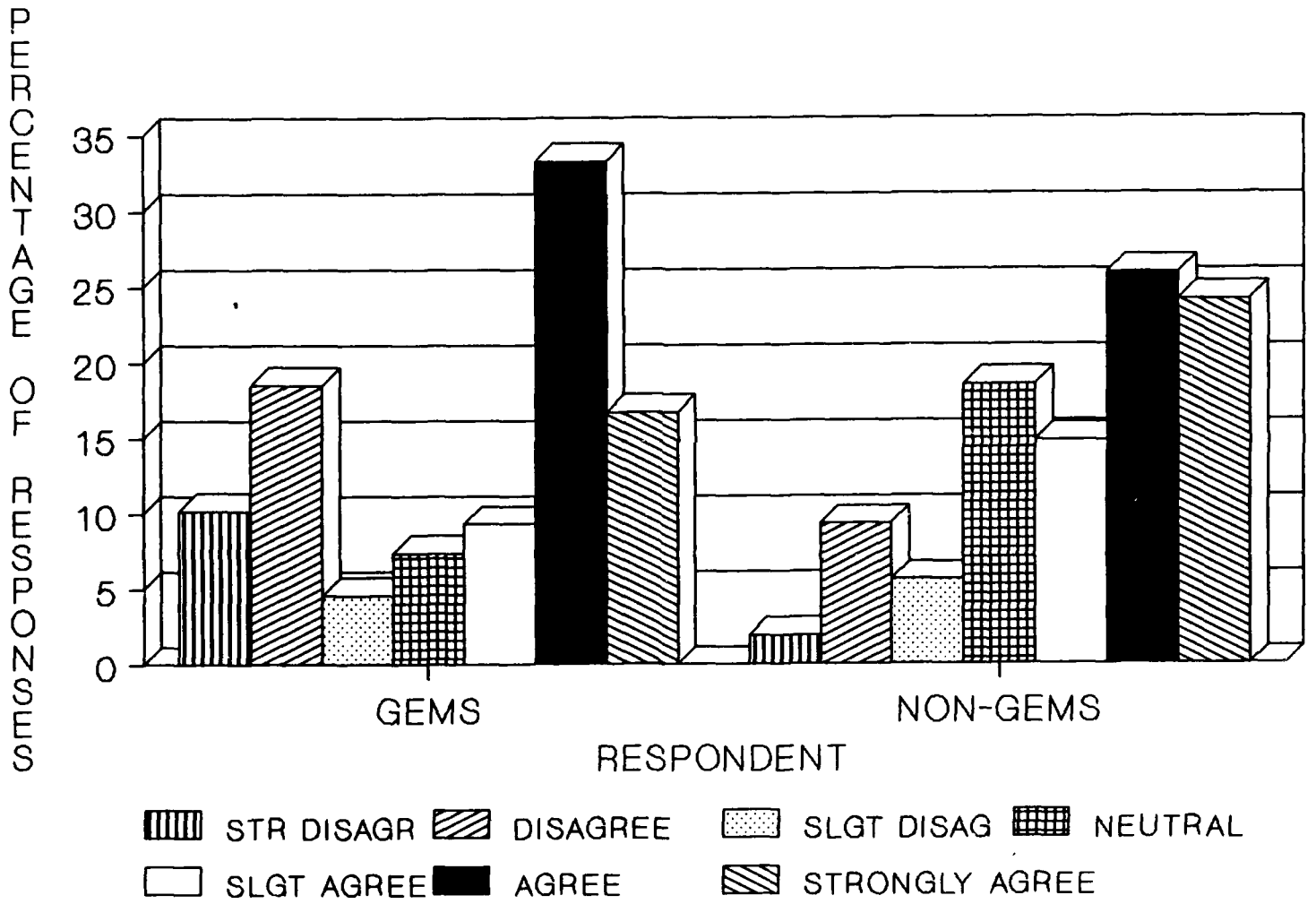

Figure 11: Would have Preferred Taking Additional Courses and Completed a Smaller Research Project Instead of a Thesis

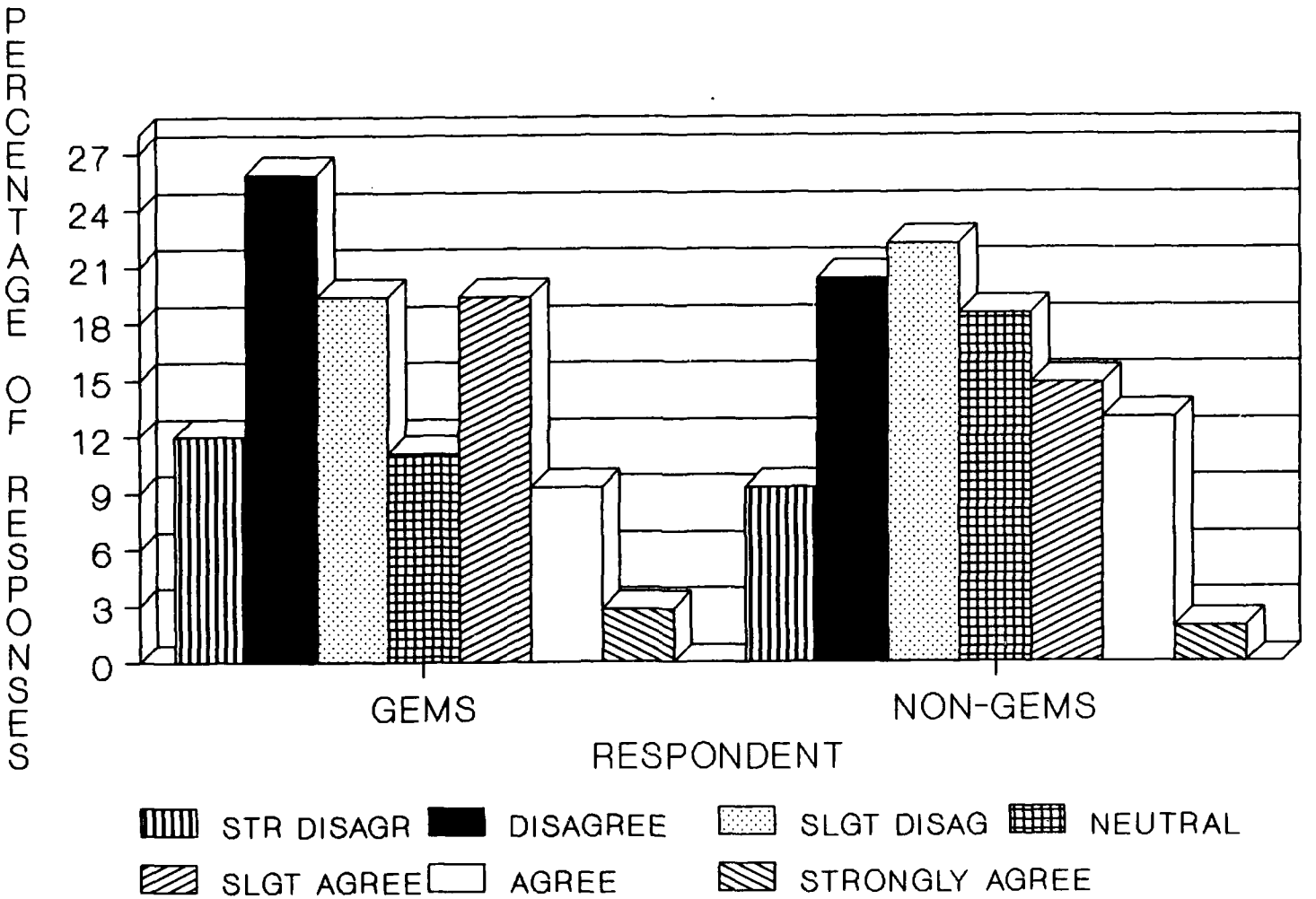

Figure 12: The Thesis is the Best Method for Learning Problem Solving Techniques

As indicated in Figure 9, both groups were practically neutral that due to their thesis effort they were better problem solvers, with the non-GEM graduates rating the question slightly higher, but not significantly. Upon analyzing the frequency responses in Figure 13 and Table XXX Appendix G, the GEM graduates responses appear bi-modal with 39.8 percent slightly to strongly disagreeing, 44.4 percent indicating they slightly to strongly agree, and 15.7 percent indicating they were neutral that as a result of their thesis effort they were better prepared to identify and solve work-related problems. The majority of the non-GEM graduates were neutral (41.8 percent) that the thesis had prepared them to be better problem solvers.

As shown in Figure 9 the non-GEM graduates agree AFIT should adopt a non-thesis option for the engineering management program; they rated this question significantly higher than the GEM graduates. As shown in Figure 14 and Table XXXI Appendix G, 50 and 61.7 percent of the GEM and non-GEM graduates strongly to slightly agree that AFIT should adopt a non-thesis option policy in the GEM program.

As portrayed in Figure 9 GEM graduates agreed their graduate education has prepared them to become effective engineering managers; they rated this significantly higher than the non-GEM graduates.

As shown in Figure 9, non-GEM graduates indicated they felt their graduate education had enhanced their promotion potential; they rated this significantly higher than the GEM

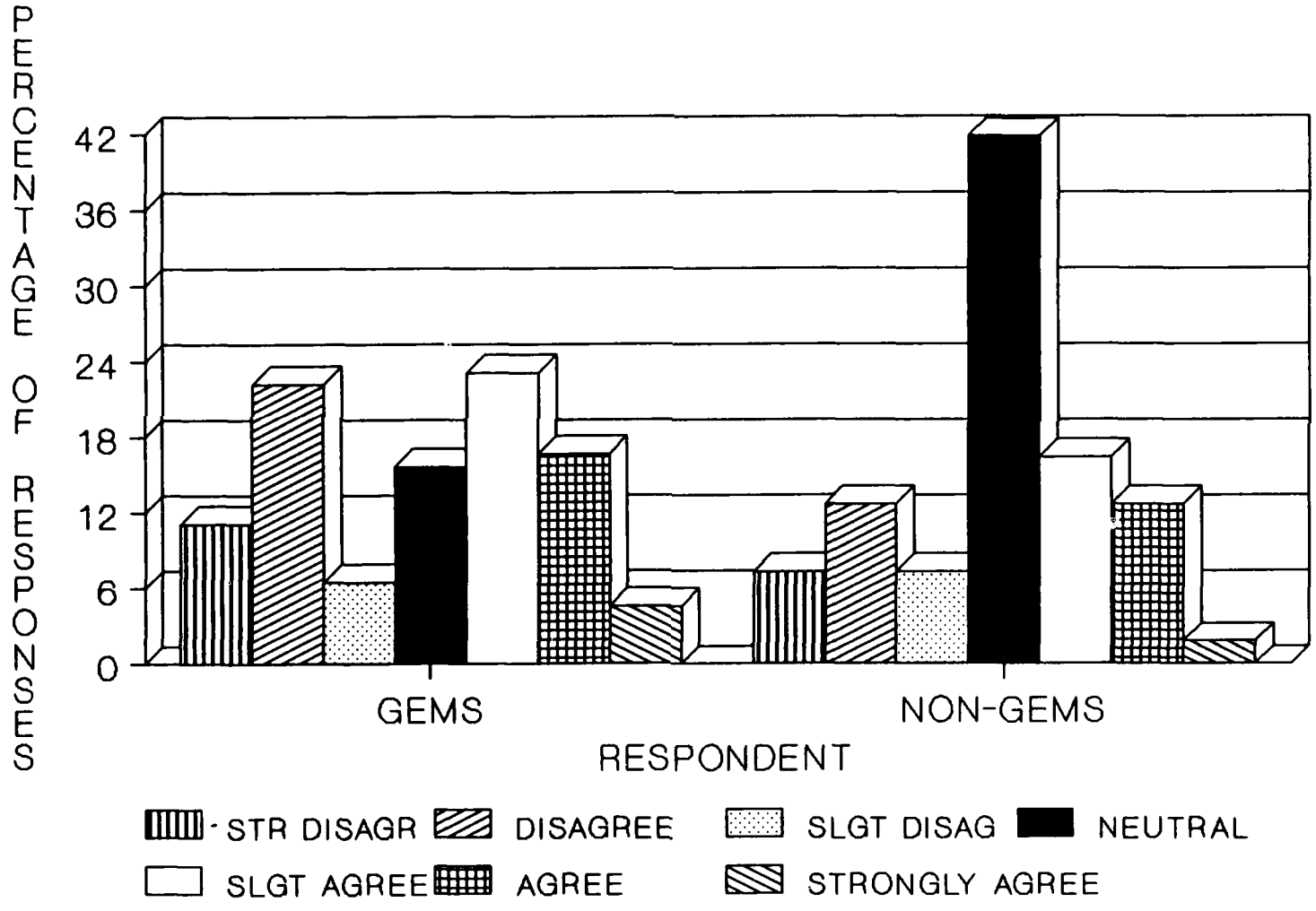

Figure 13: Better Prepared to Solve Problems on the Job Due to Completing a Thesis in Graduate School

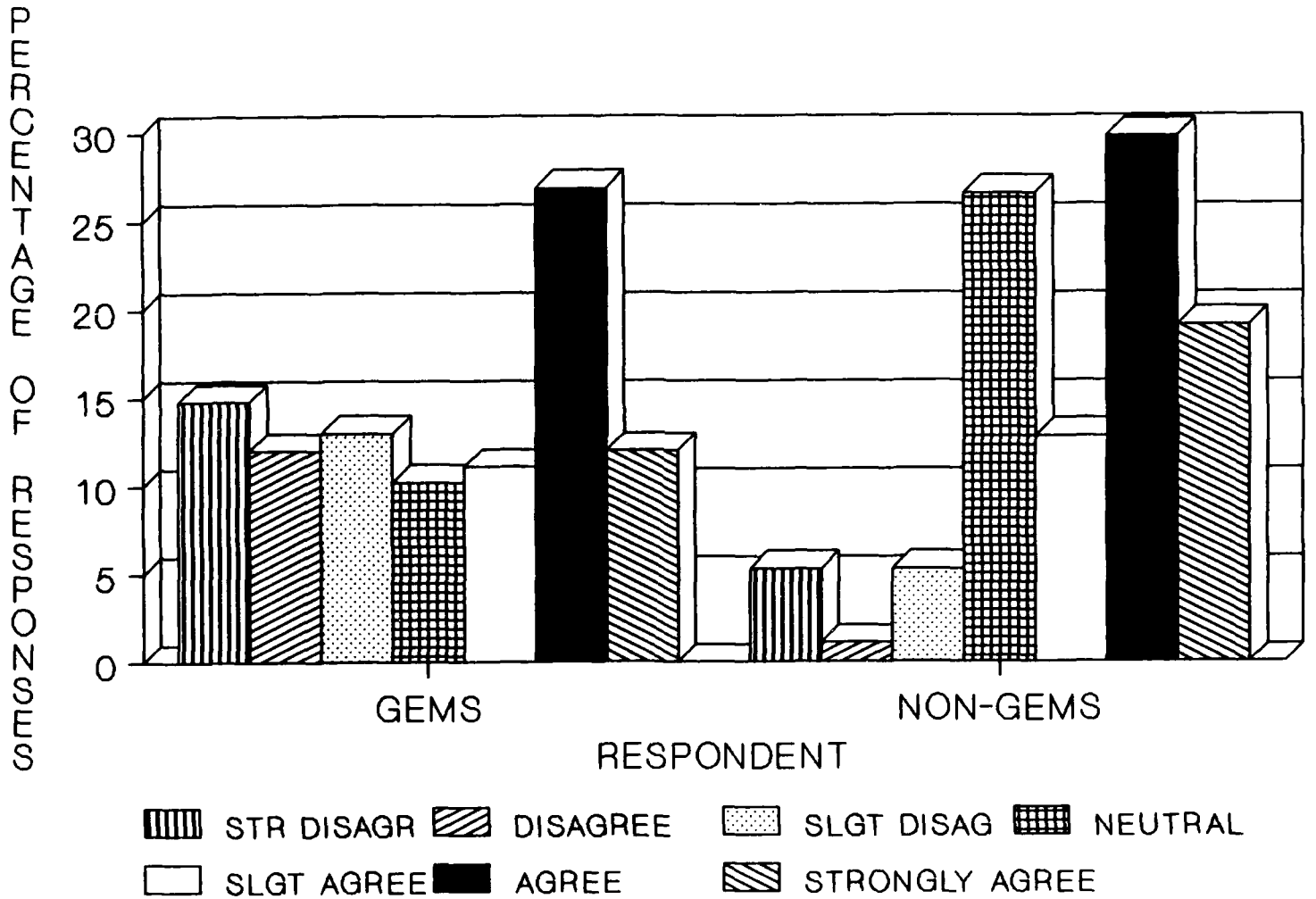

Figure 14: AFIT Should Adopt a Non-Thesis Option

graduates. In the final comparison the non-GEM graduates did not agree that a graduate degree in engineering management is the most appropriate master's degree for a civil engineering officer; in fact, they rated this topic significantly lower than GEM graduates.

Tests of Hypotheses

Hypothesis 3. GEM graduates will rate the thesis significantly higher than non-GEM graduates as the best method for learning problem solving techniques. Both groups agreed the thesis was not the best vehicle for learning problem solving techniques. Although non-GEM graduates rated this question higher than the GEM graduates, the responses were not significantly different. Thus the results did not validate this hypothesis.

Hypothesis 4. GEM graduates will rate the graduate degree in engineering management significantly higher than non-GEM graduates as the most appropriate master's degree for a civil engineering officer. GEM graduates rated a graduate degree in engineering management as the most appropriate MS degree for a civil engineering officer, significantly higher than non-GEM graduates. Thus the results support the hypothesis.

Open-Ended Questions

The purpose of the open-ended questions was to give the respondents an opportunity to express themselves in greater

detail than was possible with the structured survey questions. The responses varied greatly, and may be viewed in Appendix H.

The following question was answered by both the supervisors and the GEM graduates.

Questions 7 and 21. Currently the GEM program requires each student to complete a research thesis as part of the master's degree; this accounts for 20% of the academic requirements. Should the thesis continue to be required at AFIT or should a research project with additional course work be required?

Figure 15 on the next page displays the supervisors' and GEM graduates' responses. Twenty-seven percent of the supervisors recommended continuing the thesis, 19 percent suggested the thesis should be optional, and 54 percent of the supervisors indicated students would gain more from a research project with additional course work. A sampling of the supervisors' responses are listed below.

> "Continue the Thesis". I took the thesis, so my opinion is prejudiced. I feel I learned a great deal while doing the thesis, not only about the subject but how to write, organize, research, etc. I think the thesis should be continued.
>
> Thesis work does have its place in a master's degree program. The research and report writing can be a valuable training/educational experience for the student. Just as important, the CE community can benefit greatly from the findings of this process. Greater emphasis should be placed on thesis topic selection to ensure that "real" concerns are being addressed.
>
> "Research Project". I believe a research project in the area of civil engineering management is most appropriate. By analyzing current CE policies and/or procedures

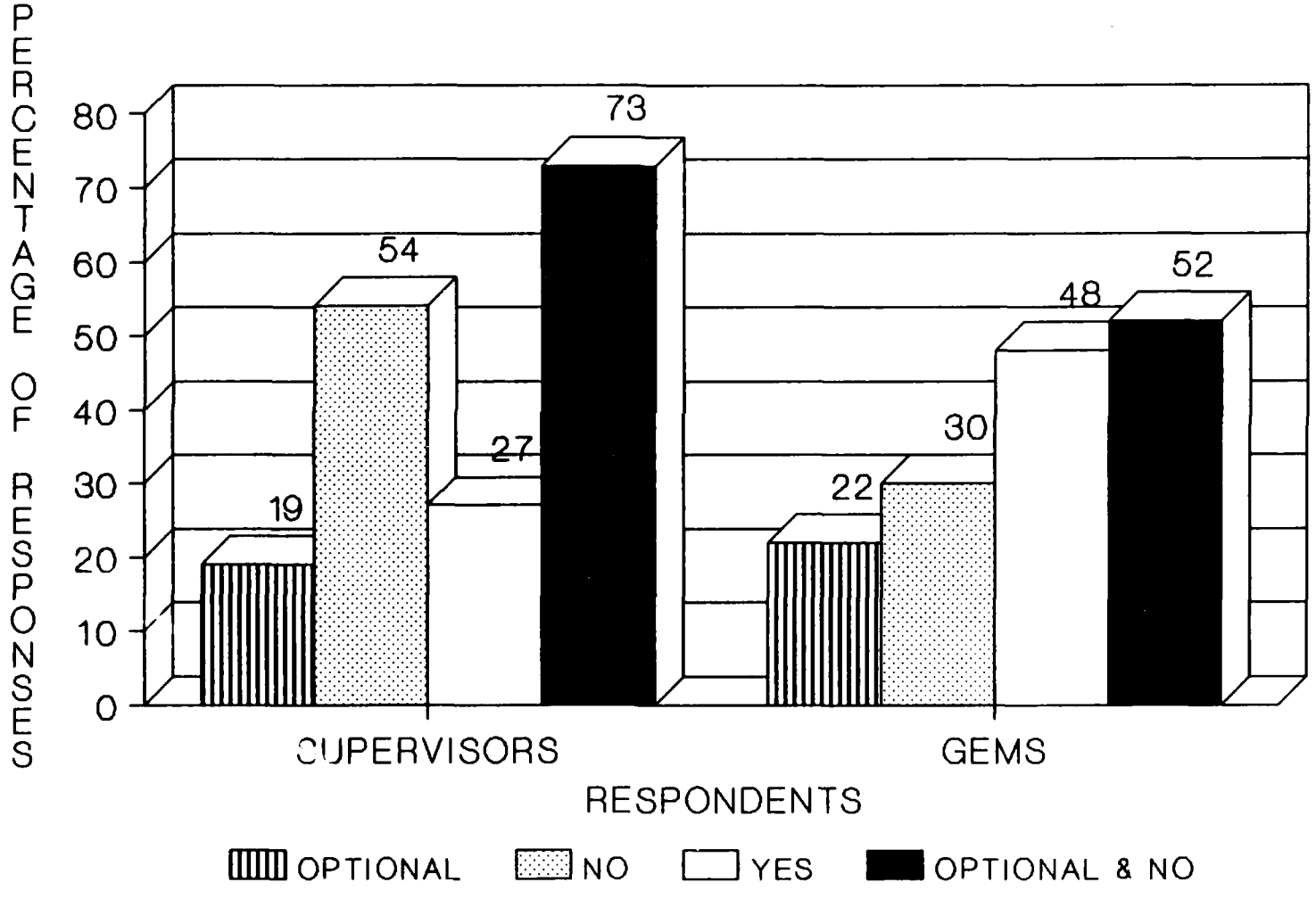

Figure 15: Continue the Thesis in AFIT GEM Program

I believe the student can best prepare him/herself for future managerial positions. Recommend the thesis be discontinued. I believe the students would gain more from a research project and additional course work. I have never found a thesis to be of value to me or my staff. Thesis out of date. Thesis did not consider cost/resources required to implement.

I feel a research project with additional course work would be more beneficial than a thesis. A broader background of studies will benefit the student more than the experience of writing a thesis.

Forty-eight percent of the GEM graduates gave a definite "yes", 22 percent suggested the thesis should be optional, and 30 percent indicated the thesis should not be required at all. These results are displayed in Figure 15 and Table XVIII, in Appendix F. Here are some of the GEM graduates responses:

"Continue the Thesis". Definitely. It enables the student to identify a problem, break it down into specific areas, research past attempts to solve the same problem, identify and recommend solutions. In other words, it forces one to think things out instead of just reacting.

Definitely yes. I feel the most benefit you get from writing a thesis is that it improves your writing skills and teaches you how to organize a large amount of information and then present it in a clear and concise manner. My thesis work really helped me be a much better officer when tasked to do involved staff work/studies. My bosses have told me they felt I was much better than my peers when it came to writing staff summary sheets, background papers, point papers, and other related studies. I think doing a lengthy thesis had a lot to do with improving my skills.

Yes, I believe the thesis should continue as an AFIT requirement. My thesis work taught me basic research/ management methods, but also, and more importantly, it honed my organizational and writing skills. These skills are the ones I've found to be most valuable in my AF work since completing AFIT. Engineers need to have good communication skills, and should be able to manage a nebulous, long-term project, and the thesis is an excellent learning tool for these skills.

"Research Project". I think a research project would fulfill the same requirement. Students should still be taught the research process. It is hard to do a good thesis in the time constraints.

No, I feel there was too little support from the field. By the time an AFIT student finished the research and published the results, the issue was, generally, no longer important. Recommend AFIT develop a doctorate program in EM and have the thesis work done there.

No, I believe the time could be better applied with emphasis on practical Air Force applications.

No. Our job in Civil Engineering is to 1) be prepared to go to war and 2) provide a service. Typically, there are relatively few opportunities in CE to apply the statistical knowledge I acquired while working the thesis. The thesis didn't help me translate the knowledge acquired in the AFIT classroom into real world/Air Force applications.

Question 8. What is the best method of teaching students how to identify and solve significant engineering management problems?

Figure 16 on the next page displays the supervisors' responses to this question, in which case studies and experience were rated first and second.

Questions 9, 23, and 19. What is the most appropriate master's degree for a civil engineering officer? All three of the surveys asked this question, and the responses are listed in Figure 17 and Table XVII Appendix F. Clearly, the supervisors, GEM graduates, and non-GEM graduates believe a master's degree in engineering management is the most appropriate degree for a civil engineering officer.

Questions 22 and 20. What is the best method of teaching students how to do research? The GEM and non-GEM

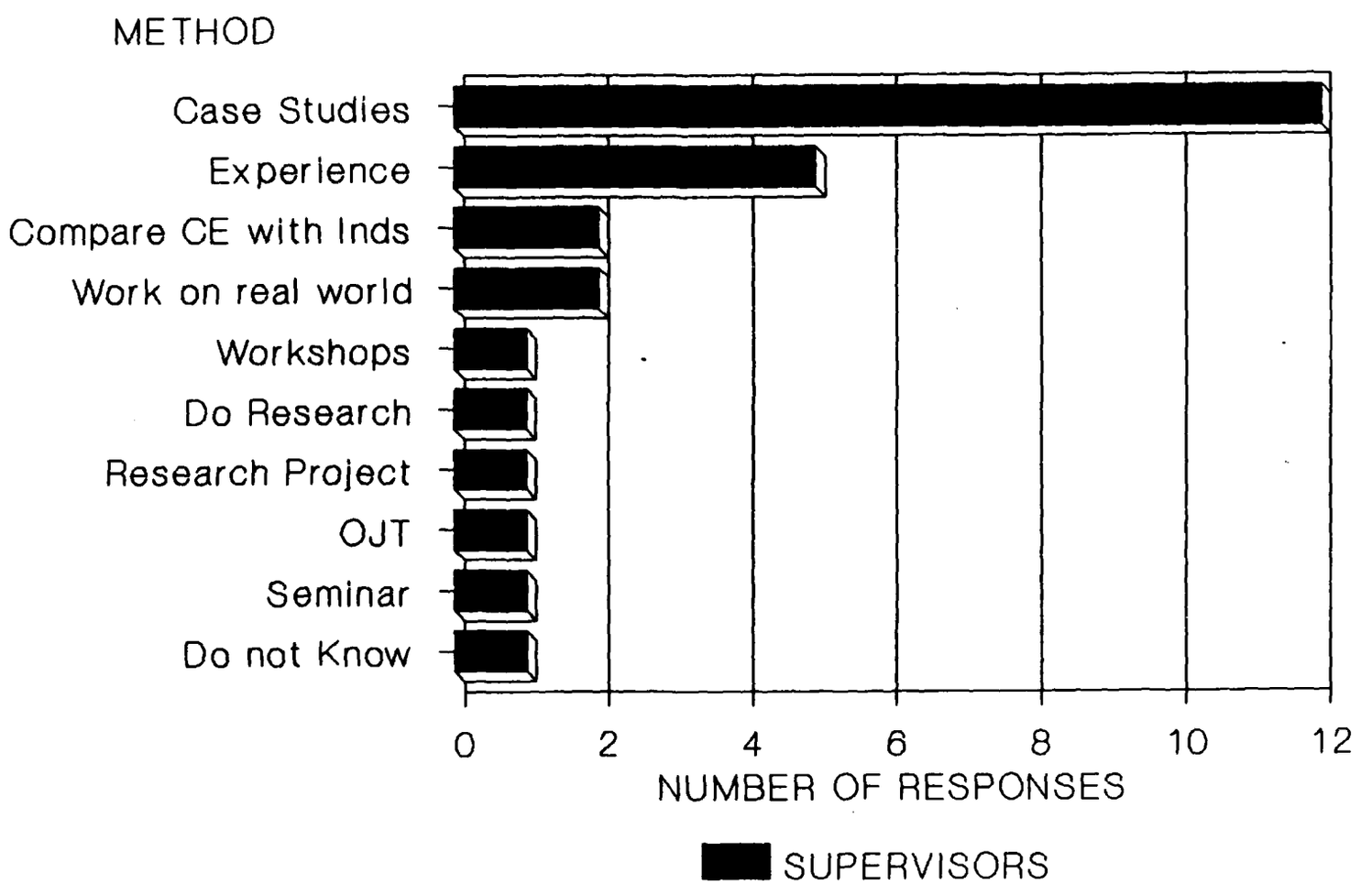

Figure 16: Best Method of Teaching Students How to Identify and Solve Significant Engineering Management Problems

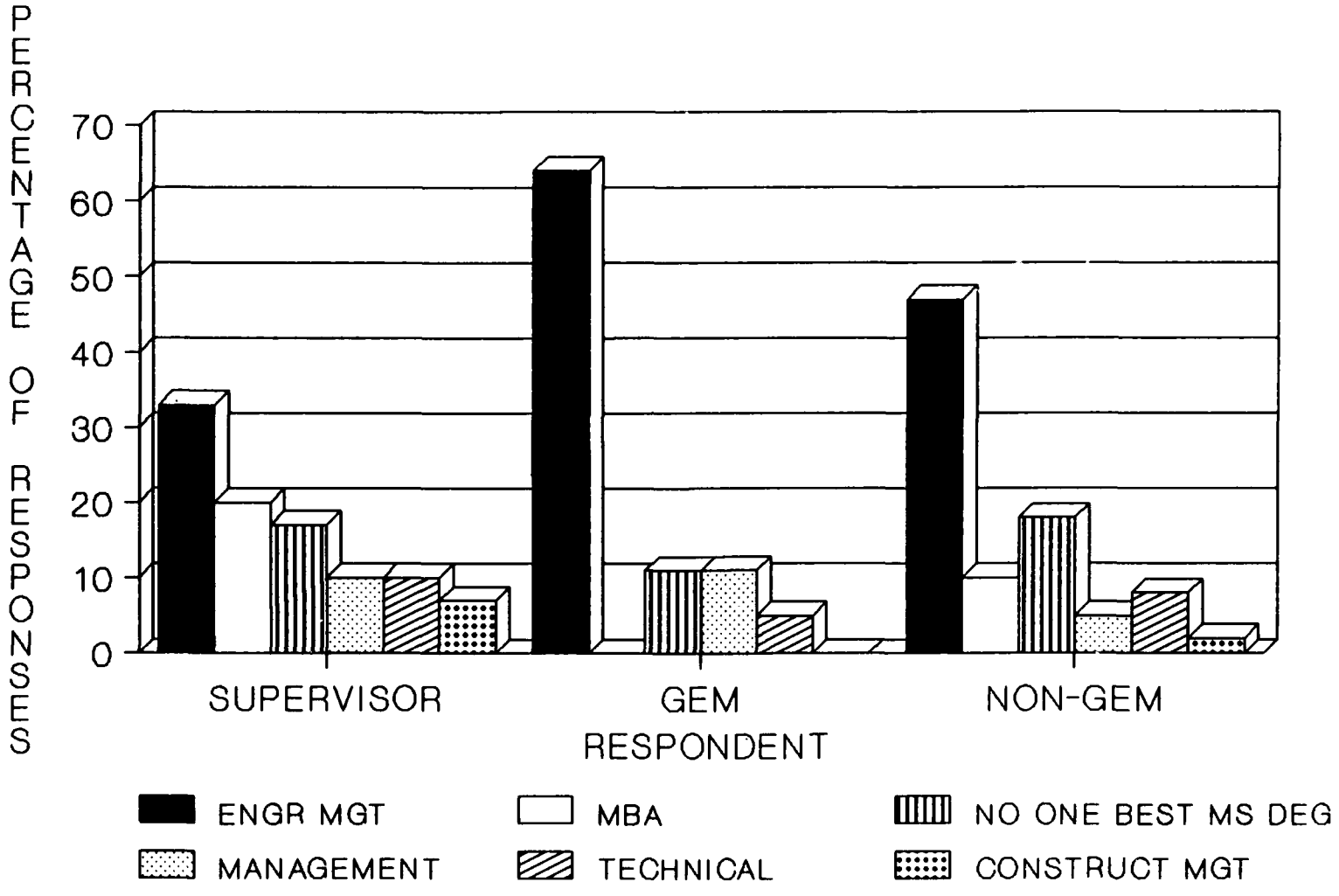

Figure 17: Most Appropriate MS Deg for Civil Engr Officer

graduates responses are displayed in Figure 18 and Table XXVII, Appendix G.

The research project is the preferred method for teaching research for the non-GEM graduates with the GEM graduates rating it second. The thesis was ranked second by non-GEM graduates, while GEM graduates rated it first. It is no surprise the GEM graduates rated the thesis first, since this is the only research option they encounter while attending AFIT in residence.

Questions 24 and 21. What is the best way to prepare civil engineering officers to be effective managers? Most of the GEM and non-GEM graduates' responses indicated experience was the best teacher. A sampling of the responses are listed below:

> As early in every career as possible, put officers in supervisory roles. Both office and field positions present leadership challenges, and academic knowledge reinforces those experiences.
>
> Encourage young men and women who want to be engineering managers to go to OTS, ROTC, and AFA. As it is, by stressing high GPAs for acceptance to OTS and for ROTC scholarships the Air Force is getting the best technical minds out there. However, many may not be interested in being managers as soon as they enter the Air Force. We need to tell them - before they commit themselves - what "engineers" in the Air Force really do. They manage. The Air Force wants their engineering background, not necessarily their expertise. The best thing the Air Force can do is to encourage and target those who want to be engineering managers. Most engineers will become managers. Some gradually, others from the start. In the Air Force, it's typically from the start. Many of the technically sharp officers coming into the Air Force seem to be getting out after their original commitment because they want to be engineers, not managers. Let's be honest with them up front.
>
> Responsibility as quickly as possible. Force them to make decisions to let them see how they impact CE

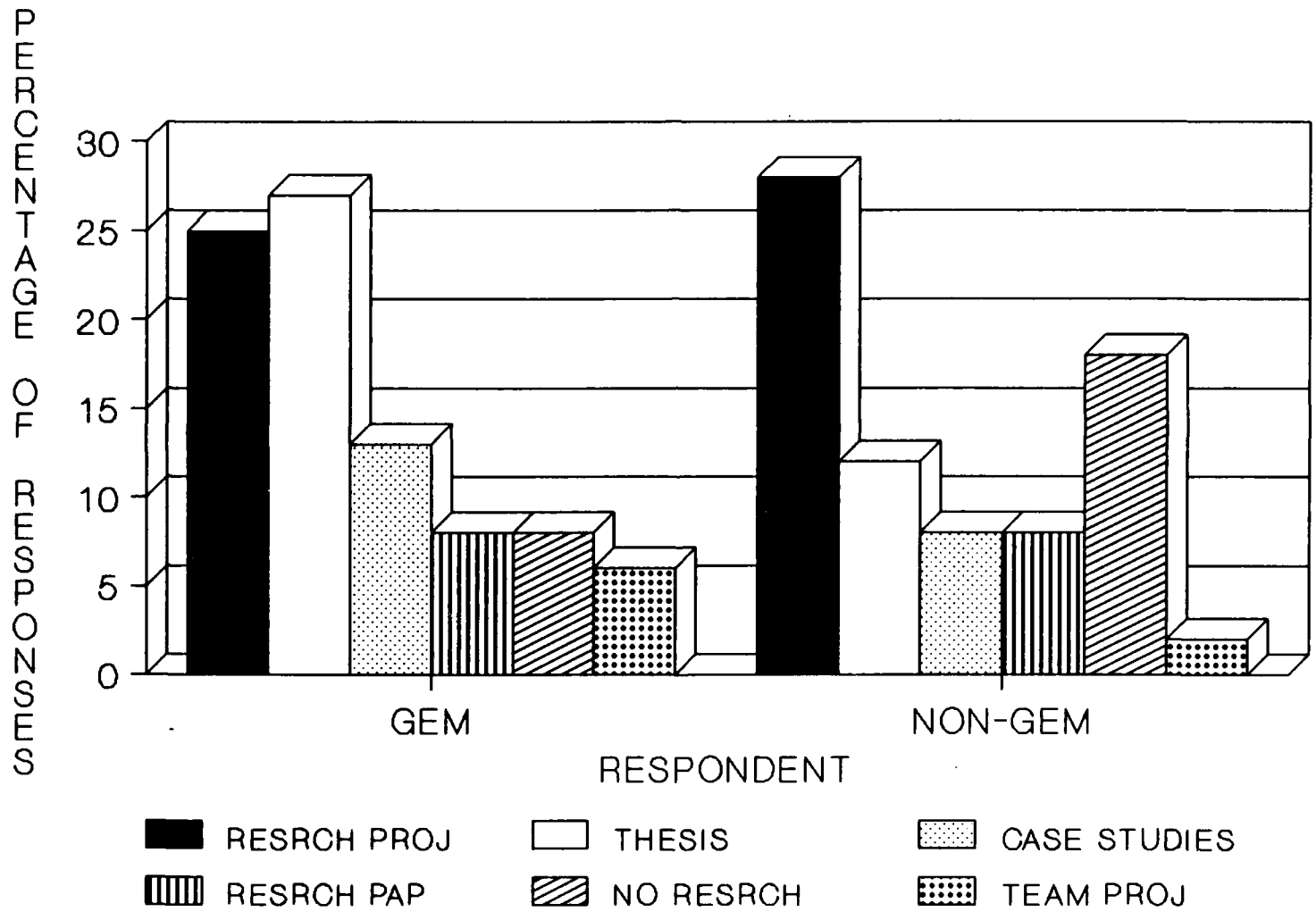

Figure 18: Best Method for Teaching Research

operations. Practice in this area combined with job experience and appropriate classroom knowledge will help prepare CE officers for their roles as managers and leaders.

Good career management ... jobs that build on one another coupled with educational opportunities such as PME in residence, AFIT short courses, and master's degree.

Experience. Then periodic courses to broaden thinking. The new OER system is right on, performance should be the key not whether or not a person has all the "squares filled" including a master's degree. The new SAC ROOM (Readiness and Ownership Oriented Management) is an attempt to bring officers into supervisory/management roles earlier. It should increase experience. It is certainly working at Wurtsmith.

Broad education; prepare for anything--both technical and managerial; need to be "fearless" in the facility maintenance/engineering business.

Summary

This chapter has presented the results and analysis of the data obtained from the three measurement surveys. A discussion of the results and the conclusions that can be inferred from these result are summarized in Chapter V.

V. Discussion and Conclusions

Introduction

This chapter presents a discussion of the findings of this study and some conclusions that may be inferred from the results. In addition, some study limitations and recommendations for further research are offered.

Overview of Research Effort

This research study was undertaken to determine how well the GEM program accomplishes its primary mission of preparing civil engineering officers to become effective engineering managers. The primary purpose was to determine if there were any discernible differences in performance between GEM graduates and non-GEM graduates. The secondary research objective was to determine if completing the thesis prepares GEM graduates to be better problem solvers. The study directly asked the supervisors of GEM and non-GEM graduates to assess their job performance and problem solving ability in comparison with their peers.

The data was collected by mailing separate surveys to three groups of active duty Air Force civil engineering officers: 1) those who supervise a GEM and non-GEM graduate; 2) those who have completed the GEM program; and 3) those who have completed their master's degree by any method other than the GEM program.

The surveys asked three types of questions: demographic, perceptual, and open-ended. The demographic data was tabulated to provide a "snapshot" of the respondents. The perceptual questions on the supervisors' surveys addressed job performance and problem solving skills. The responses to the questions were rated on a seven-point Likert scale, which allowed calculation of the means. The means and standard deviations were used to determine if there were any significant differences between the GEM and non-GEM graduates.

The responses were analyzed using SPSS^{x}. The results were presented in chapter IV. Open-ended questions allowed the respondents to relay additional information the structured questions could not capture. The following sections present the findings based on those responses.

Demographic Results

Based on the demographics, the average supervisor was a male colonel or lieutenant colonel with more than 11 years of managerial experience in civil engineering, who has supervised one or more GEM graduates. He probably completed his master's degree at a civilian university (AFIT/CI) and satisfied the research option by writing a thesis. The colonel also believes his job requires a master's degree to do it right.

There was no typical GEM or non-GEM graduate. Both groups displayed a diversified background, with only these

predominate characteristics: male captain with an undergraduate degree in civil engineering. The non-GEM probably completed his graduate degree independently, selecting the non-thesis option.

Research Questions

Research Question 1. Based on the perceptions of the graduates' supervisors, are there any discernible differences in performance between GEM and non-GEM graduates?

There were eight measures pertaining to job performance for GEM and non-GEM graduates (Figures 9 and 10, Chapter IV). Statistical evidence shows that the GEM graduates as a group exhibited no discriminating differences in job performance from non-GEM graduates.

It is quite apparent the supervisors avoided using the high and low extremes of the rating scale and clustered the mean responses for both groups at slightly better than average (central tendency error).

There was little deviation between the ratings for the GEM graduates and non-GEM graduates. As shown in this research study the system allows inflated ratings, because the supervisor is neither rewarded or punished for evaluating subordinates. Thus to give high ratings is socially acceptable. High ratings enhance employee-supervisor relationships, employees are content and this makes the supervisor's job easier. Conversely, low ratings evoke negative reactions and cause animosity between employees and supervisors.

Additionally, all Air Force officers receive management training throughout their careers, with the initial management training being administered at either the Air Force Academy, Officers Training School (OTS), or through the Air Force Reserve Officer Training Corp (AFROTC). They continue this management training in professional military training (PME) courses; Squadron Officers School (SOS), Air Command and Staff College (ACSC), and Air War College (AWC).

In addition, the best method for capturing the effect of the GEM program on job performance and problem solving ability would be to have the same supervisor rate the graduates before attending AFIT and after graduation. Yet, this was not possible due to the mobility of the graduates and the supervisors. A cross-sectional study, in which measures are taken at one point in time, was the only alternative available.

Obviously, it is difficult to determine exact causal relationships between variables. Unlike a longitudinal study, which takes measures over several periods of time, a cross-sectional study allows only educated inferences at causal relationships.

Research Question 2. Based on the perceptions of the graduates' supervisors, are there any differences in problem solving ability between a GEM graduate and a non-GEM graduate?

Supervisors rated GEM graduates significantly higher on two of the five measures rating problem solving ability. Air Force civil engineering supervisors indicated GEM graduates performed significantly better than non-GEM

graduates on projects requiring extensive research. Supervisors also indicated that as a group GEM graduates were significantly better problem solvers than non-GEM graduates--possibly due to the breadth of analytical techniques the GEM graduates are exposed to while attending AFIT.

Because GEM students are highly screened prior to acceptance, they may have already possessed the attributes allowing them to perform better than their peers. Thus the treatment--the GEM program--may not have been the sole reason for enhancement of the graduates' job performance or problem solving skills.

Research Question 3. Based on the perceptions of the GEM and non-GEM graduates, is the thesis the best method for learning problem solving skills?

Both the GEM and non-GEM graduates (57.3 and 51.9 percent) agree the thesis was not the best method for learning problem solving techniques, as displayed in Figure 19, on the following page. Fifty-percent of the GEM graduates and 61.7 percent of the non-GEM graduates agree that AFIT should adopt a non-thesis option in the GEM program. Frequency responses are shown in Figure 20. In an open-ended question, 52 percent of the GEM graduates indicated AFIT should discontinue the thesis or make it optional.

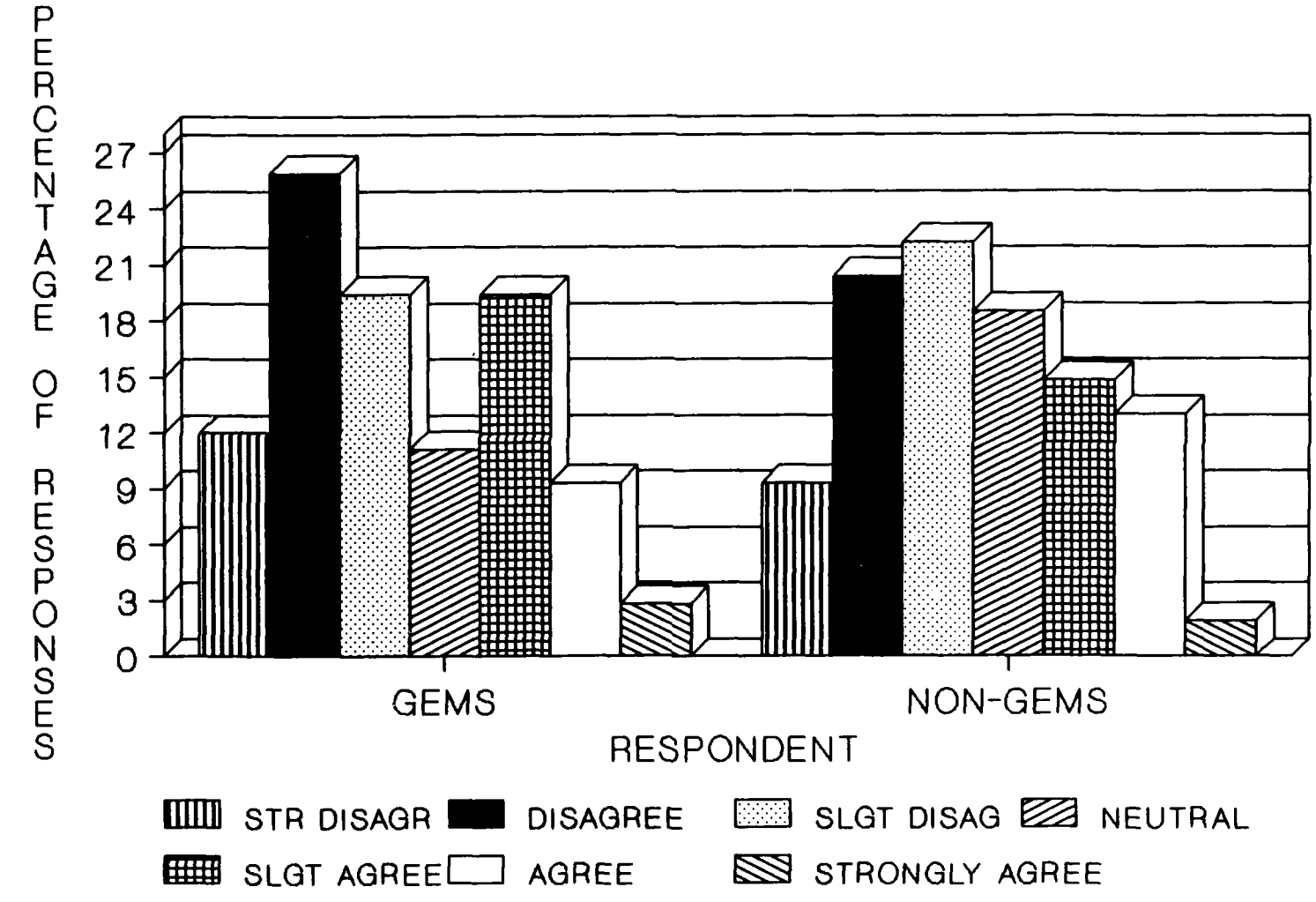

Figure 19: The Thesis is the Best Method for Learning Problem Solving Techniques

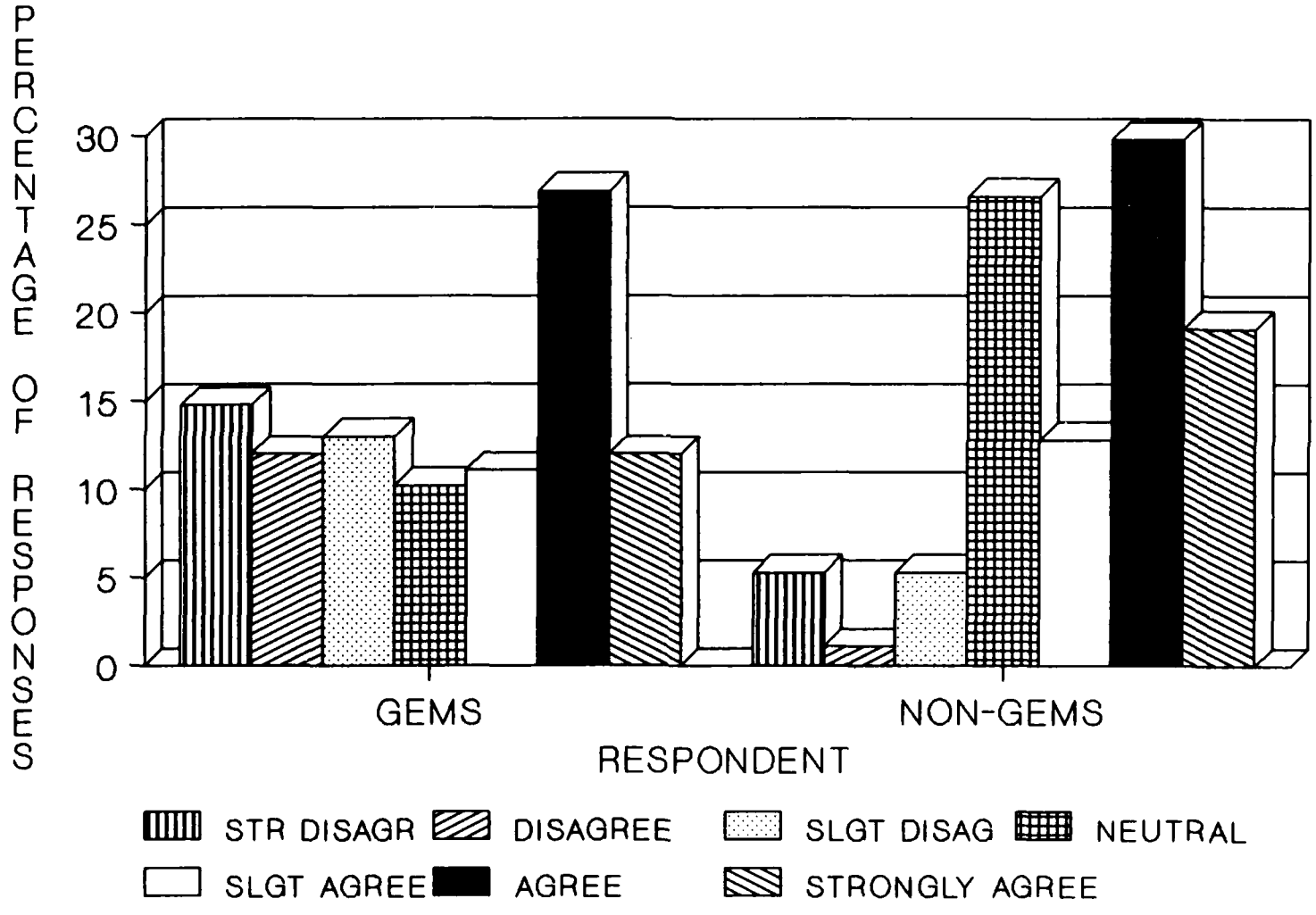

Figure 20: AFIT Should Adopt a Non-Thesis Option

Other Findings

Supervisors. Supervisors indicated that as a group GEM graduates understand systems modeling and how to apply these techniques in the decision process much better than non-GEM graduates. The GEM graduates are taught how the decisions they make in their sections may impact all other aspects of the organization (Figure 7, Chapter IV).

GEM graduates appear to have a better understanding of the financial systems used in the federal government. This could possibly be due to the Federal Financial Management course they take during the program. GEM graduates as a group displayed better writing skills than non-GEM graduates. Although the supervisors ranked the non-GEM graduates slightly higher on seven of the 22 measures, none were statistically significant.

Throughout this research project, Air Force civil engineering supervisors stated "we send our best to AFIT". Thus, GEM graduates scoring higher than non-GEM graduates on 15 of the 22 questions simply quantifies this attitude.

GEM Graduates. GEM graduates indicated that the GEM program was beneficial, and they highly recommend it to other civil engineering officers. Next, GEM graduates indicated their AFIT education has enhanced their promotion potential. The non-GEM graduates also agreed that completing a graduate program had prepared them to function better as engineering managers.

Of the GEM graduates, 59 percent would have preferred taking additional course work with a research project in lieu of the thesis. In addition, 50 percent of the GEM graduates indicated they agree that AFIT should adopt a non-thesis option like other graduate engineering programs.

They appeared bi-modal on the issue that they were better problem solvers due to their thesis effort, with 39.8 percent slightly to strongly disagreeing and 44.4 percent slightly to strongly agreeing.

The GEM graduates felt the courses did not deal with too much theory, and indicated the courses had real world applications. Additionally, 57.3 percent of the GEM graduates indicated the thesis was not the best method for learning problem solving techniques.

Fifty-three percent of the GEM graduates indicated the workload was about right, while 26.9 percent thought it was a little heavy. The graduates also indicated the length of the program was just about right (64.8 percent), but 21.3 percent indicated it was too short. The respondents who thought the program was a little heavy and too short were undoubtedly GFM graduates, but since the program increased to 15 months in 1980, most respondents indicated the program was adequate for the academic rigor required.

Non-GEM Graduates. Non-GEM graduates as a group indicated that obtaining a master's degree had enhanced their promotion potential. Sixty-five percent of the non-GEM graduates would have preferred taking additional courses

and completing a smaller research project instead of the thesis. The non-GEM graduates agree that AFIT should adopt a non-thesis option. Non-GEM graduates also indicated their graduate degree has prepared them to be better engineering managers, but 41.8 percent of the non-GEM graduates were unsure if the thesis had made them better problem solvers. Non-GEM graduates disagree that the thesis is the best method of learning problem solving techniques.

Comparisons Between GEM and Non-GEM Graduates. The non-GEM graduates rated writing papers for courses higher than GEM graduates, but not significantly. Non-GEM graduates rated taking additional courses and completing a smaller research project in lieu of the thesis significantly higher than the GEM graduates.

Both groups believe the thesis is not the best method for learning problem solving techniques, although the non-GEM graduates rated it higher, but not significantly. Both groups were neutral that their thesis efforts prepared them to be better problem solvers, with the non-GEM graduates rating it slightly higher, but not significantly. Non-GEM graduates agree that AFIT should adopt a non-thesis option for the engineering management program. They rated this significantly higher than the GEM graduates.

Open-Ended Questions. Both the supervisors and GEM graduates were asked if the thesis should be continued at AFIT, or should a research project with additional course work be required? Twenty-seven percent of the supervisors

recommended continuing the thesis, 19 percent suggested the thesis should be optional, and 54 percent of the supervisors indicated students would gain more from a research project with additional course work.

Forty-eight percent of the GEM graduates gave a definite "yes", 22 percent suggested the thesis should be optional, and 30 percent indicated the thesis should not be required at all, as indicated in Figure 21.

According to the survey respondents, the most appropriate master's degree for a civil engineering officer is engineering management, as displayed in Figure 22. Supervisors and non-GEM graduates rated the MBA second, while GEM graduates selected general management. Additionally, all three groups said there was no one "best" MS degree for civil engineering officers. Clearly, AFIT is providing an appropriate master's degree for civil engineering officers to meet their mission and professional development requirements.

Although the respondents believe AFIT is offering the appropriate MS degree for civil engineering officers, there is much debate if the thesis is the best method for teaching students how to do research. The GEM graduates indicated the thesis was the best method for teaching research in an open-ended question. Yet they gave question 12, "The thesis is the best method for learning problem solving techniques" the lowest rating on the survey, indicating they disagree that the thesis is the best method for teaching research.

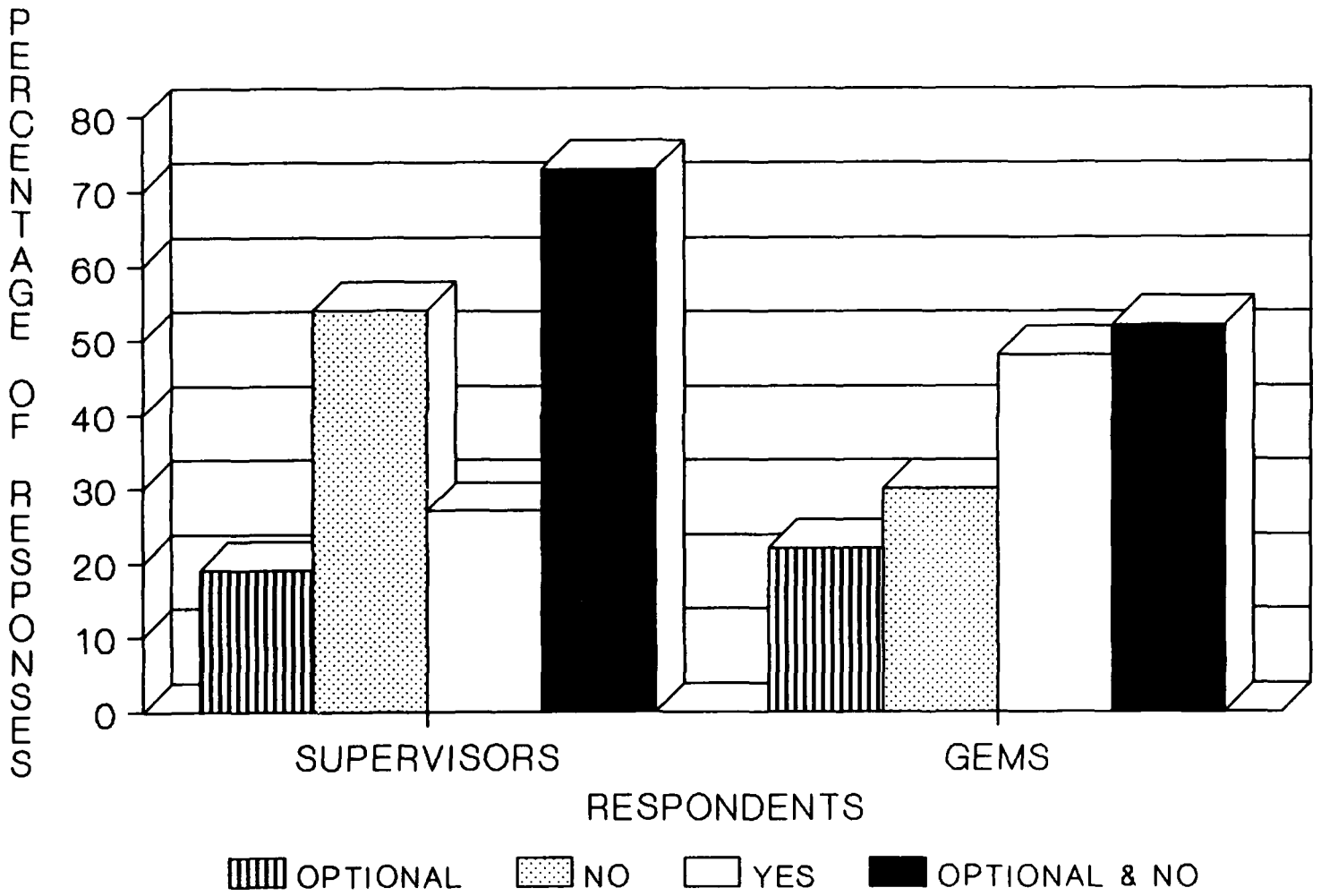

Figure 21: Continue Thesis in AFIT GEM Program

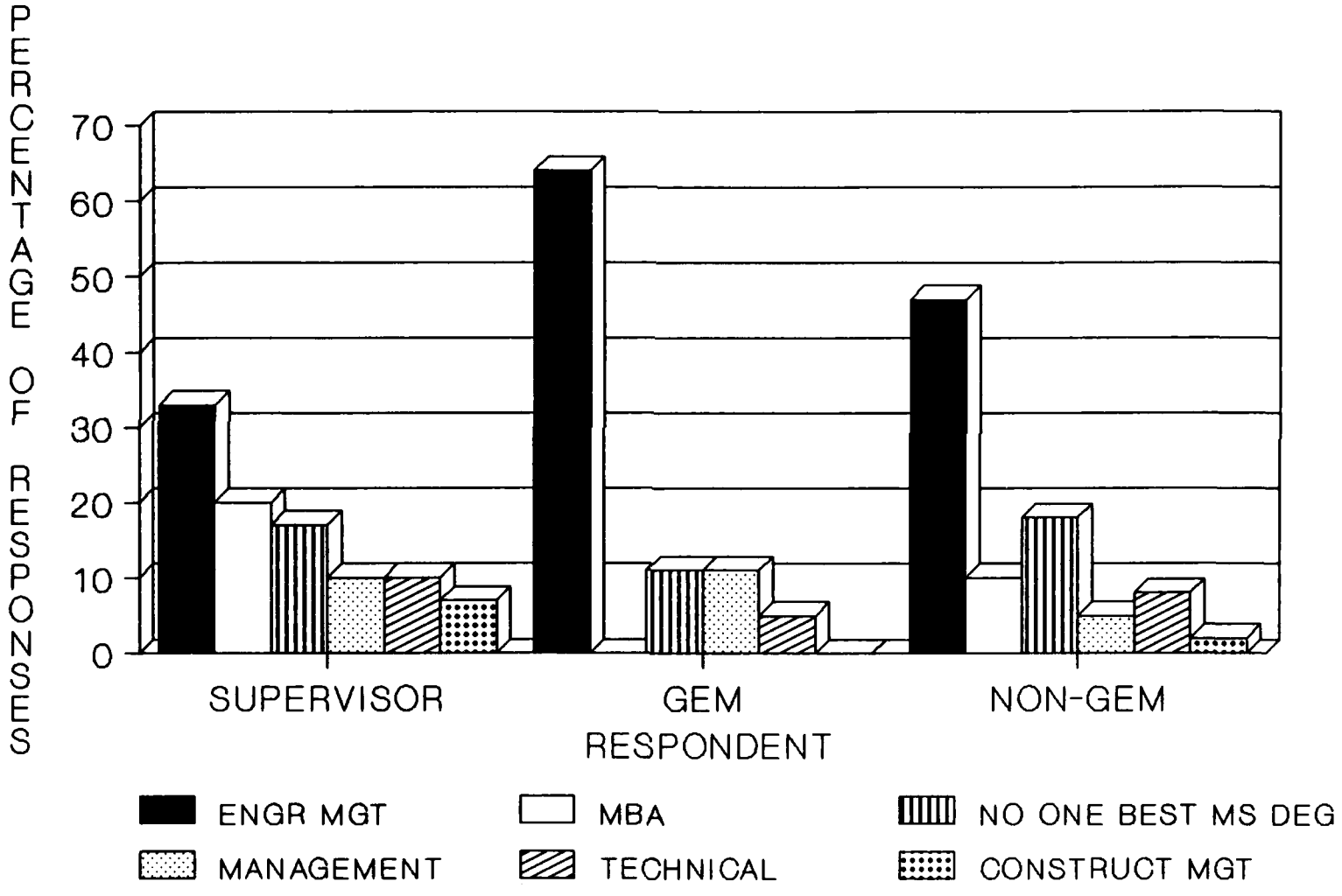

Figure 22: Most Appropriate MS Deg for Civil Engr Officer

The GEM graduates response to the open-ended question was based on what they knew best--the thesis.

The non-GEM graduates indicated the research project was the best method for teaching students how to conduct research. Many engineering schools are moving from the thesis to the research project as the primary method of teaching the research process to graduate students. Yet some non-GEM graduates wondered why AFIT should teach research at all (18 percent).

As seen in Chapter II, most engineering management programs are oriented for the working professional. The strict research methodology required to complete the thesis, without viewing it as preparation for the doctoral level, is not attractive to the student. In fact, since the engineering management program began in 1967 at the University of Missouri-Rolla, only 5 percent of the MS students have completed a thesis. This research effort validates the literature presented in chapter II that the engineering management degree is a terminal degree for practicing engineers who want to develop their management skills in the shortest time possible and enhance their promotion potential.

Conclusions

Three of the four hypotheses were supported by the results, and some important conclusions may be drawn from this study.

First, evaluations by civil engineering supervisors, on the average, indicated there are no significant differences in performance between GEM graduates and non-GEM graduates.

Second, supervisors' assessments of the GEM graduate's problem solving ability were significantly higher than non-GEM graduates. While no statistical study can ever prove causality, this study convincingly establishes associations between participation in the GEM program and problem solving ability.

Both the GEM and non-GEM graduates (57.3 and 51.9 percent) agree the thesis is not the best method for learning problem solving techniques.

Seventy-three percent of the supervisors and 52 percent of the GEM graduates indicated AFIT should discontinue the thesis or make it optional. Sixty-five percent of the non-GEM graduates indicated they would have preferred taking additional courses and completing a research project instead of the thesis. They strongly believe AFIT should adopt a non-thesis option.

The engineering management degree was perceived as the most appropriate graduate degree in terms of promotion potential in the Air Force civil engineering career field.

Recommendations

1. AFIT should consider making the thesis optional in the GEM program and offer a research project. The master's degree in engineering management was developed for working

engineers to obtain the managerial education they did not receive in their undergraduate studies. Learning how to conduct formal academic research was not the primary goal of these programs. Learning management skills to do their jobs better and enhancing their promotion potential were the main objectives.

2. Major commands should continue to provide support to the GEM program in the form of research topics and real world problems to aid the students' educational development.

3. The Air Force should continue sending civil engineering officers to the GEM program.

Recommendations for Further Research

1. This single measurement, while useful, could be improved by conducting a longitudinal study to determine if there is any difference in performance before and after completing the GEM program. In addition, the study could be used to determine if completing the thesis prepares civil engineering officers to be better problem solvers.

2. A similar study should be conducted, increasing the sample size to raise the validity of the statistical results by surveying GEM graduates who are stationed overseas.

3. A subsequent study could be conducted, but the data should be obtained by evaluating the GEM graduate's officer evaluation reports to determine if there are any significant differences in job performance and problem solving ability after completion of the GEM program.

Summary

GEM graduates as a group displayed no discernible differences in job performance from non-GEM graduates. However, the supervisors indicated GEM graduates are significantly better problem solvers than non-GEM graduates. Both the GEM and non-GEM graduates agree the thesis was not the best method for learning problem solving techniques. In addition, 73 percent of the supervisors, 52 percent of the GEM graduates, and 61.7 percent of the non-GEM graduates agree that AFIT should discontinue the thesis or make it optional.

The results of this research study will help the GEM program manager evaluate how well the GEM program prepares civil engineering officers for management positions in the Air Force. As with any academic institution, AFIT must periodically obtain feedback from the field to verify that the professional development courses being taught are relevant to current needs.

Appendix A: Powerpack Program

```
* FILE: tsmdss.pwr;
*-------------------------------------------------;
TEST Two Sample Two-Sided t-Test ;
*-------------------------------------------------;
* This is a Test About the Difference Between Two ;
* Population Means From Normal Populations With
* UNKNOWN Variances that are presumed TO BE EQUAL;
*-------------------------------------------------;
 Type = t, two; df=n+n-2;  Alpha = siglev;
 H0nc = (delta0-delta0)/sqrt(pooledv*((1/n)+(1/n)));
 H1nc = (delta1-delta0)/sqrt(pooledv*((1/n)+(1/n)));
*-------------------------------------------------;
* Below we declare a variable to place the Power;
* of the test into and retain this variable and;
* the one or more alternate values of mu so we;
* can plot the Power Function;
*-------------------------------------------------;
 PwrVar = PowerOfTest; retain PowerOfTest,delta1,n;
*-------------------------------------------------;
prompt delta0, delta1, siglev, xbar, ybar, varx, vary, n;
define pooledv=(((n-1)/(n+n-2)*varx)+((n-1)/(n+n-2)*vary));
run;
retain n,poweroftest,delta1;
*
*     Output the Computed Value of the Test Statistic;
*           and the P-Value for this Sample;
* -------------------------------------------------;
 let tstar=((xbar-ybar) - delta0)/
                sqrt(pooledv*((1/n)+(1/n)));
 show tstar;
 let probval = 2*(1 - tcdf(abs(tstar),n+n-2,0));
 show probval;
*     Compute and Output the Probability of Type II Error;
* -------------------------------------------------;
 let Beta = 1- PowerOfTest;
 show Beta;
 save perform;
```

Appendix B: Supervisor Survey Instrument

INSTRUCTIONS: This questionnaire contains 53 items (individual "questions"). Part I requests demographic information on you, Part II and III pertain to the GEM graduate. Part IV and Part V pertain to the Non-GEM graduate. If you do not find a response that fits your situation exactly, use the one closest to the way you feel. Please fill in the circle (using a # 2 lead pencil) on the computer scansheet enclosed with the survey. If you select an "Other" response, place the answer on the computer scansheet and also write your answer on the survey. Please do not omit any questions.

Keywords

The following are definitions of key words that recur throughout the questionnaire:

I. GEM Graduate: Civil Engineering officers who have received their master's degree in Engineering Management, In-residence at the AFIT School of Systems and Logistics, WPAFB, Ohio.

II. Non-GEM Graduate: Civil Engineering officers who have received their master's degree by any method, other than the GEM program.

III. Peer: Civil Engineering officer of equivalent rank and time in the 55XX career field.

Each response block on the computer scan sheet has 7 spaces numbered 1 though 7. Questionnaire items are answered by marking the appropriate space on the computer scansheet as in the following example:

Rate this officer compared to his/her peers using the following scale to select your responses:

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

Sample statement

Accomplishes any task assigned with minimal guidance.

If you decide he/she is "better" than his/her peers, you would "blacken in" the corresponding number of that statement (better = 6) on the computer scansheet.

Sample response:

PART I--BACKGROUND INFORMATION

Please complete the following demographic questions (they pertain to you). Fill in the circle (using a # 2 pencil) on the computer scansheet enclosed with the survey. If you select an "Other" response place the answer on the computer scansheet and also write your answer on the survey. Please do not omit any questions.

1. My current pay grade is:

   1. 01
   2. 02
   3. 03
   4. 04
   5. 05
   6. 06
   7. Other (please specify)_____.

2. How many years of managerial experience do you have in the Civil Engineering career field?

   1. Less than 1
   2. 1 to less than 3
   3. 3 to less than 5
   4. 5 to less than 7
   5. 7 to less than 9
   6. 9 to less than 11
   7. More than 11

3. If you have a Master's Degree how did you complete it?

   1. I did not complete a master's degree
   2. On my own time
   3. AFIT part time not in residence
   4. AFIT in residence
   5. AFIT/CI (civilian institute)
   6. Other (please specify)_____.

4. If you completed a Master's Degree program, which research option did you complete?

   1. I did not complete a master's degree
   2. Thesis
   3. Case Study
   4. Non-thesis option (additional course work no comprehensive exam)
   5. Research project with additional course work
   6. Non-Thesis with/final comprehensive exam
   7. Other (please specify)_____.

5. In your opinion, do you need a master's degree to do your job?

1. Yes
2. No

6. How many AFIT Graduate Engineering Management (GEM) graduates have you supervised over your career (you were their reporting official)?

1. 0
2. 1 - 2
3. 3 - 4
4. 5 - 6
5. 7 - 8
6. 9 or more
7. I do not know

Open Ended Questions - In this section, please write your responses in the space below each question.

7. Currently the GEM program requires each student to complete a research thesis as part of the master's degree, this accounts for 20% of the academic requirements. Should the thesis continue to be required at AFIT or should a research project with additional course work be required?

8. What is the best method of teaching students how to identify and solve significant Engineering Management problems?

9. What is the most appropriate master's degree for a civil engineering officer?

Part II--Job Effectiveness (GEM Graduate)

INSTRUCTIONS: Use the rating scale given below to express your assessment of this GEM graduate's performance in his/her job. Note that each rating scale refers to a different aspect of work performance so there may be some amount of variation between performance dimensions shown for an individual. Fill in the number on the computer answer sheet that best describes this officer's performance compared to the performance of his/her peers (officers of equivalent rank, and time in the 55XX career field) doing similar work.

Rate this officer compared to his/her peers using the following scale to select your responses:

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

10. Quantity of Output

    Productivity in terms of units of work produced or services rendered.

11. Quality of Work

    The degree to which work products are free from error and/or conform to standards and specifications.

12. Efficiency of Work

    The degree to which resources (e.g., money, material, and personnel) are used to their maximum capacity and waste is kept to a minimum.

13. Adaptability/Flexibility

    Represents the ability to adjust to special circumstances (e.g., "crash projects" and sudden schedule changes) and perform under less than optimal conditions.

14. Overall Effectiveness

INSTRUCTIONS: Use the rating scale given below to indicate how effective this GEM graduate is at his/her job in comparison with his/her peers (officers of equivalent rank, and time in the 55XX career field).

Rate this officer compared to his/her peers using the following scale to select your responses:

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

15. Understands and applies the basic concepts and principles of management.

16. Guides his/her people effectively in accomplishing organizational goals.

17. Displays a good understanding of human behavior, individual and group.

18. Understands the benefits of system modeling in the decision making process and uses system modeling techniques in the decision making process.

19. Displays a good basic knowledge of the financial systems used in the federal government.

20. Displays a good understanding of the quantitative techniques (forecasting, statistical quality control, and project management) which may be applied to the management of engineering activities.

21. Accomplishes any task assigned with minimal guidance.

22. Uses the informal organization effectively to accomplish difficult tasks.

23. Meets my personal expectations for managerial expertise in doing his job.

24. Effectively plans and organizes his/her work.

Part III--Problem Solving Ability (GEM Graduate)

INSTRUCTIONS: Use the rating scale given below to rate the problem solving ability of this GEM graduate in comparison with peers (officers of equivalent rank, and time in the 55XX career field).

Rate this officer compared to his/her peers using the following scale to select your responses:

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

25. Problem-Solving Capacity

Represents the ability of the GEM graduate to anticipate problems that may come up and either prevent them or minimize their impact upon operation of the work unit.

26. How well does this officer perform on a project requiring extensive research in comparison with his/her peers?

27. How do you rate this officer's writing ability?

28. How do you rate this officer's problem solving ability?

29. Utilizes a systematic approach when solving problems.

30. Applies knowledge gained through formal education in solving real world problems.

31. Understands the managers role in solving problems, guiding employees and allowing them to mature and gain confidence in their abilities.

This completes the evaluation of the GEM graduate. Please continue, the next section evaluates the Non-GEM graduate.

Part IV--Job Effectiveness (Non-GEM Graduate)

INSTRUCTIONS: Use the rating scale given below to express you assessment of this Non-GEM graduate's (CE officer who has received his/her master's degree by any method other than the GEM program) performance in his/her job. Note rating scale refers to a different aspect of work performance so there may be some amount of variation between performance dimensions shown for an individual. Fill in the number on the computer scansheet that best describes this officer's performance compared to the performance of his/her peers (officers of equivalent rank, and time in the 55XX career field) doing similar work.

Rate this officer compared to his/her peers using the following scale:

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

32. Quantity of Output

Productivity in terms of units of work produced or services rendered.

33. Quality of Work

The degree to which work products are free from error and/or conform to standards and specifications.

34. Efficiency of Work

The degree to which resources (e.g., money, material, and personnel) are used to their maximum capacity and waste is kept to a minimum.

35. Adaptability/Flexibility

Represents the ability to adjust to special circumstances (e.g., "crash projects" and sudden schedule changes) and perform under less than optimal conditions.

36. Overall Effectiveness

INSTRUCTIONS: Use the rating scale given below to indicate how effective this Non-GEM graduate is at his/her job in comparison with their peers (officers of equivalent rank, and time in the 55XX career field).

Rate this officer compared to his/her peers using the following scale:

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

37. Understands and applies the basic concepts and principles of management.

38. Guides his/her people effectively in accomplishing organizational goals.

39. Displays a good understanding of human behavior, individual and group.

40. Understands the benefits of system modeling in the decision making process and uses system modeling techniques in the decision process.

41. Displays a good basic knowledge of the financial management concepts used in the federal government.

42. Displays a good understanding of the quantitative techniques (forecasting, statistical quality control, and project management) which may be applied to the management of engineering activities.

43. Accomplishes any task assigned with minimal guidance.

44. Uses the informal organization effectively to accomplish difficult tasks.

45. Meets my personal expectations for managerial expertise in doing his job.

46. Effectively plans and organizes his/her work.

Part V--Problem Solving Ability (Non-GEM Graduate)

INSTRUCTIONS: Use the rating scales given below to rate the problem solving ability of this Non-GEM graduate in comparison with peers (officers of equivalent rank, and time in the 55XX career field).

Rate this officer compared to his/her peers using the following scale to select your responses:

Much Worse	Worse	Slightly Worse	About The Same	Slightly Better	Better	Much Better
1	2	3	4	5	6	7

47. Problem-Solving Capacity

Represents the ability to anticipate problems that may come up and either prevent them or minimize their impact upon operation of the work unit.

48. How well does this officer perform on a project requiring extensive research in comparison with his/her peers?

49. How do you rate this officer's writing ability?

50. How do you rate this officer's problem solving ability?

51. Utilizes a systematic approach when solving problems.

52. Applies knowledge gained through formal education in solving real world problems.

53. Understands the managers role in solving problems, guiding employees and allowing them to mature and gain confidence in their abilities.

Thank you for completing this questionnaire. Please enclose the computer scansheet and the questionnaire in the envelope and return to AFIT/LSG.

Appendix C: GEM Survey Instrument

INSTRUCTIONS

This questionnaire contains 24 items (individual "questions"). Part I is demographic information, Part II pertains to your AFIT education, and Part III concludes with open-ended questions. If you do not find a response that fits your situation exactly, use the one closest to the way you feel. Please fill in the circle (using a # 2 pencil) on the computer scansheet enclosed with the survey. If you select an "Other" response, place the answer on the computer scansheet and also write your answer on the survey. Please do not omit any questions.

Each response block on the computer scan sheet has 7 spaces, numbered 1 though 7. Questionnaire items are answered by marking the appropriate space on the computer scansheet as in the following example:

Sample statement

I enjoy working in the civil engineering career field.

Use the following scale to select your responses:

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

If you "Agree" with the sample statement, you would "blacken in" the corresponding number of that statement (agree = 6) on the computer scansheet.

Sample response:

PART I--BACKGROUND INFORMATION

Please complete the following demographic questions. Fill in the circle (using a # 2 lead pencil) on the computer scansheet enclosed with the survey. If you select an "Other" response, place the answer on the computer scansheet and also write your answer on the survey. Please do not omit any questions.

1. My current rank is?

   1. Second Lieutenant
   2. First Lieutenant
   3. Captain
   4. Major
   5. Lieutenant Colonel
   6. Other (please specify)_____.

2. What section in Civil Engineering do you work?

   1. Resources/Logistics
   2. Operations
   3. Readiness
   4. Contract Management
   5. Design
   6. Environmental and Contract Planning
   7. Other (Please specify)_____.

3. What is your sex?

   1. Male
   2. Female

4. What is your age?

   1. Less than 24 years
   2. 25-27 years
   3. 28-30 years
   4. 31-33 years
   5. 34-36 years
   6. 37-40 years
   7. 41 years or greater

5. What was your undergraduate major?

   1. Civil Engineering
   2. Electrical Engineering
   3. Mechanical Engineering
   4. Industrial Engineering
   5. Architectural Engineering
   6. Architecture
   7. Other (please specify)_____.

6. How many years of managerial experience do you have in the Civil Engineering career field?

1. 1 to less than 4
2. 4 to less than 7
3. 7 to less than 10
4. 10 to less than 13
5. 13 to less than 16
6. 16 to less than 19
7. More than 19 years

7. I graduated from AFIT in _____.(Please specify the year)

Part II. This section contains general statements pertaining to your AFIT Education.

INSTRUCTIONS: If you do not find a response that fits your situation exactly, use the one closest to the way you feel. Please fill in the circle (using a # 2 lead pencil) on the computer scansheet enclosed with the survey. Please do not omit any questions.

Use the following scale to select your responses:

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

8. I feel the courses dealt too much with theory.

9. I feel the courses did not have real world application.

10. Writing papers for courses enhanced my knowledge of course material or related subject areas.

11. I would have preferred taking additional course work and completing a smaller research project in lieu of the thesis.

12. The thesis is the best method for learning problem solving techniques.

13. As a result of my thesis effort, I am better prepared to identify and solve problems in my job.

Use the following scale to select your responses:

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

14. Many Engineering Management programs, at civilian institutions offer the non-thesis option today. I believe AFIT should adopt this policy.

15. My AFIT education prepared me to become an effective engineering manager.

16. I recommend the GEM program to other civil engineering officers.

17. My AFIT education has enhanced my promotion potential.

18. A Graduate degree in Engineering Management is the most appropriate master's degree for a civil engineering officer.

19. The workload for the AFIT program I completed was.

1. Much too light
2. Too light
3. A little light
4. About right
5. A little heavy
6. Too heavy
7. Much too heavy

20. The length of the AFIT program was:

1. Much too long
2. Too long
3. A little long
4. About right
5. A little short
6. Too short
7. Much too short

Part III. In this section, please write your responses in the space below each question.

21. Currently the GEM program requires each student to complete a research thesis as part of the master's degree, this accounts for 20% of the academic requirements. Should the thesis continue to be required at AFIT?

22. What is the best method of teaching students how to do research?

23. What is the most appropriate master's degree for a civil engineering officer?

24. What is the best way to prepare CE officers to be effective managers?

Thank you for completing this questionnaire. Please enclose the computer scansheet and the questionnaire in the envelope and return to AFIT/LSG.

Appendix D: Non-GEM Graduate Survey Instrument

INSTRUCTIONS USAF SCN 88-41

This questionnaire contains 21 items (individual "questions"). Part I is demographic information, Part II has questions about your graduate education, and Part III concludes with open-ended questions. If you do not find a response that fits your situation exactly, use the one closest to the way you feel. Please fill in the circle (using a # 2 pencil) on the computer scansheet enclosed with the survey. If you select an "Other" response, place the answer on the computer scansheet and also write your answer on the survey. Please do not omit any questions.

Each response block on the computer scan sheet has 7 spaces, numbered 1 though 7. Questionnaire items are answered by marking the appropriate space on the computer scansheet as in the following example:

Sample statement

I enjoy working in the civil engineering career field.

Use the following scale to select your responses:

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

If you "Agree" with the sample statement, you would "blacken in" the corresponding number of that statement (agree = 6) on the computer scansheet.

Sample response:

1988 NON-GEM GRADUATE SURVEY - PART I BACKGROUND INFORMATION

Please complete the following demographic questions. Fill in the circle (using a # 2 lead pencil) on the computer scansheet enclosed with the survey. If you select an "Other" response place the answer on the computer scansheet and also write your answer on the survey. Please do not omit any questions.

1. My current rank is?

   1. Second Lieutenant
   2. First Lieutenant
   3. Captain
   4. Major
   5. Lieutenant Colonel
   6. Other (please specify)_____.

2. What section in Civil Engineering do you work?

   1. Resources/Logistics
   2. Operations
   3. Readiness
   4. Contract Management
   5. Design
   6. Environmental and Contract Planning
   7. Other (Please specify)_____.

3. What is your sex?

   1. Male
   2. Female

4. What is your age?

   1. Less than 24 years
   2. 25-27 years
   3. 28-30 years
   4. 31-33 years
   5. 34-36 years
   6. 37 years or greater

5. What was your undergraduate major?

   1. Civil Engineering
   2. Electrical Engineering
   3. Mechanical Engineering
   4. Industrial Engineering
   5. Architectural Engineering
   6. Architecture
   7. Other (please specify)_____.

6. Year you completed your master's degree _____?

7. How many years of managerial experience do you have in the Civil Engineering career field?

1. 1 to less than 4
2. 4 to less than 7
3. 7 to less than 10
4. 10 to less than 13
5. 13 to less than 16
6. 16 to less than 19
7. More than 19 years

8. How did you complete your Master's Degree program?

1. On my own time
2. AFIT part time not in residence
3. AFIT in residence
4. AFIT/CI (civilian institute)
5. NA
6. Other (please specify)_____.

9. If you completed a Master's Degree program, which research option did you complete?

1. Thesis
2. Case Study
3. Non-thesis option (additional course work taken)
4. Other (please specify)_____.
5. NA

Part II. This section contains general statements pertaining to your Master's Degree (Graduate) education. If you do not find a response that fits your situation exactly, use the one closest to the way you feel.

Use the following scale to select your responses: If you did not complete a thesis omit questions 10-12.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

10. I would have preferred taking additional course work and completing a smaller research project in lieu of the thesis.

11. The thesis is the best method for learning problem solving techniques.

12. As a result of my thesis effort, I am better prepared to identify and solve problems in my job.

Use the following scale to select your responses:

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

13. Writing papers for courses enhanced my knowledge of course material or related subject areas.

14. Many Engineering Management programs, at civilian institutions offer the non-thesis option today. I believe AFIT should adopt this policy.

15. My graduate education (master's degree) prepared me to become an effective engineering manager.

16. Obtaining my graduate degree has enhanced my promotion potential.

17. A Master's degree in Engineering Management is the most appropriate graduate degree for a civil engineering officer.

18. I believe my chances for promotion are better than an AFIT GEM graduate.

Part III. In this section, please write your responses in the space below each question.

19. What is the most appropriate master's degree for a civil engineering officer?

20. What is the best method of teaching students how to do research?

21. What is the best way to prepare CE officers to be effective managers?

Thank you for completing this questionnaire. Please enclose the computer scansheet and the questionnaire in the envelope and return to AFIT/LSG.

Appendix E: SPSS* Programs

```
TITLE            ANALYSIS OF SUPERVISOR DATA'
FILE HANDLE      THESIS / NAME = 'super.dat'
DATA LIST        FILE= THESIS FIXED RECORDS= 1 / Q1 TO Q53
                 (8x,53F1)
SET              BLANKS=9, WIDTH=80
VARIABLE LABELS  Q1   'CURRENT GRADE'
                 Q2   'YRS OF MANAGERIAL EXPR IN CE CAREER FIELD'
                 Q3   'HOW MASTERS DEGREE WAS COMPLETED'
                 Q4   'RESEARCH OPTION USED IN MS DEGREE'
                 Q5   'IS A MS DEGREE REQUIRED TO DO YOUR JOB'
                 Q6   'NUMBER OF GEM GRADUATES SUPERVISED'
VALUE LABELS     Q1 (1)01 (2)02 (3)03 (4)04 (5)05 (6)06 (7)OTHER /Q2
                 (1)LESS THAN 1 (2)1 TO LESS THAN 3
                 (3)3 TO LESS THAN 5
                 (4)5 TO LESS THAN 7 (5)7 TO LESS THAN 9
                 (6)9 TO LESS THAN 11 (7)MORE THAN 11 / Q3
                 (1)DID NOT COMPLETE A MS DEGREE (2)ON MY OWN
                 (3)AFIT PART TIME NOT IN RESIDENCE
                 (4)AFIT IN RESIDENCE (5)AFIT-CI (6)OTHER / Q4
                 (1)DID NOT COMPLETE A MASTERS DEGREE (2)THESIS
                 (3)CASE STUDY
                 (4)NON-THESIS OPTION (5) RESEARCH PROJECT
                 (6) NON-THESIS WITH ADDITIONAL COURSE WORK
                 (7)OTHER/Q5 (1) YES (2) NO / Q6 (1) 0 (2) 1 TO 2
                 (3) 3 TO 4
                 (4) 5 TO 6
                 (5) 7 TO 8 (6) 9 OR MORE (7)I DO NOT KNOW/
MISSING VALUES   Q1 TO Q53 (9)
FREQUENCIES      VARIABLES=Q1 (1,7) Q2 (1,7) Q3 (1,6) Q4 (1,7)
                 Q5 (1,2) Q6 (1,7)/ HISTOGRAM
T-TEST           PAIRS=Q10 WITH Q32/Q11 WITH Q33/ Q12 WITH Q34/ Q13
                 WITH Q35/ Q14 WITH Q36/ Q15 WITH Q37/ Q16 WITH Q38/
                 Q17 WITH Q39/ Q18 WITH Q40/ Q19 WITH Q41/ Q20 WITH
                 42/ Q21 WITH Q43/ Q22 WITH Q44/ Q23 WITH Q45/ Q24
                 WITH Q46/ Q25 WITH Q47/ Q26 WITH Q48/ Q27 WITH Q49/
                 Q28 WITH Q50/ Q29 WITH Q51/ Q30 WITH Q52/ Q31 WITH
                 Q53/
RELIABILITY      VARIABLES= Q10,Q11,Q12,Q13,Q14,Q21,Q22,Q24/
                 SCALE(PERFORM)=Q10 TO Q24
                 VARIABLES= Q25,Q26,Q28,Q29,Q30/
                 SCALE(PROBSOL)=Q25 TO Q30
RELIABILITY      VARIABLES= Q32,Q33,Q34,Q35,Q36,Q43,Q44,Q46/
                 SCALE(PERFORM)=Q32 TO Q46
                 VARIABLES= Q47,Q48,Q50,Q51,Q52/
                 SCALE(PROBSOL)=Q47 TO 52
FINISH
```

```
TITLE            ANALYSIS OF GEM DATA'
FILE HANDLE      THESIS / NAME = 'gem.dat'
DATA LIST        FILE= THESIS FIXED RECORDS= 1 / Q1 TO Q20
                 (8x,20F1)
SET              BLANKS=9, WIDTH=80
VARIABLE LABELS  Q1  'CURRENT RANK'
                 Q2  'WORKING SECTION IN CE'
                 Q3  'SEX'
                 Q4  'AGE'
                 Q5  'UNDERGRADUATE DEGREE'
                 Q6  'YRS OF MANAGERIAL EXPR IN CE'
VALUE LABELS     Q1 (1)02 (2)03 (3)03+ (4)04 (5)05 (6)OTHER / Q2
                 (1)RESOURCES-LOG (2)OPER (3)READINESS (4) CONT MGT
                 (5) DESIGN (6) ENVIOR CONT PLANNING (7) OTHER / Q3
                 (1) MALE (2) FEMALE / Q4 (1) LESS THAN 24 (2) 25-27
                 (3) 28-30 (4) 31-33 (5) 34-36 (6) 37-40 (7) 41+ /Q5
                 (1) CIVIL (2) ELEC (3) MECH (4) IE (5) ARCH ENGR
                 (6) ARCH (7) OTHER / Q6 (1) 1 TO LT 4 (2) 4 TO LT 7
                 (3) 7 TO LT 10 (4) 10 TO LT 13 (5) 13 TO LT 16
                 (6) 16 TO LT 19 (7) MORE THAN 19
MISSING VALUES   Q1 TO Q20 (9)
FREQUENCIES      VARIABLES=Q1 (1,6) Q2 (1,7) Q3 (1,2) Q4 (1,7)
                 Q5 (1,7) Q6 (1,7) Q7 TO Q20 (1,7)/ HISTOGRAM/
                 STATISTICS= MEAN STDDEV DEFAULT/

FINISH
```

```
TITLE            ANALYSIS OF NON-GEM DATA'
FILE HANDLE      THESIS / NAME = 'ngem.dat'
DATA LIST        FILE= THESIS FIXED RECORDS= 1 / Q1 TO Q18
                 (8x,18F1)
SET              BLANKS=9, WIDTH=80
VARIABLE LABELS  Q1   'CURRENT RANK'
                 Q2   'WORKING SECTION IN CE'
                 Q3   'SEX'
                 Q4   'AGE'
                 Q5   'UNDERGRADUATE DEGREE'
                 Q7   'YRS OF MANAGERIAL EXPR IN CE'
                 Q8   'METHOD MS WAS COMPLETED'
                 Q9   'TYPE OF RESEARCH OPTION IN MS'
VALUE LABELS     Q1 (1)02 (2)03 (3)03+ (4)04 (5)05 (6)OTHER / Q2
                 (1)RESOURCES-LOG (2)OPER (3)READINESS (4) CONT MGT
                 (5) DESIGN (6) ENVIOR CONT PLANNING (7) OTHER / Q3
                 (1) MALE (2) FEMALE / Q4 (1) LESS THAN 24 (2) 25-27
                 (3) 28-30 (4) 31-33 (5) 34-36 (6) 37+ / Q5
                 (1) CIVIL (2) ELEC (3) MECH (4) IE (5) ARCH ENGR
                 (6) ARCH (7) OTHER / Q7 (1) 1 TO LT 4 (2) 4 TO LT 7
                 (3) 7 TO LT 10 (4) 10 TO LT 13 (5) 13 TO LT 16
                 (6) 16 TO LT 19 (7) MORE THAN 19 / Q8 (1) ON MY OWN
                 (2) AFIT PART TIME (3) AFIT IN RESIDENCE
                 (4) AFIT-CI (5) NA (6) OTHER / Q9 (1) THESIS
                 (2) CASE STUDY (3) NON-THESIS OPTION (4) OTHER
                 (5) NA/
MISSING VALUES   Q1 TO Q18 (9)
FREQUENCIES      VARIABLES=Q1 (1,6) Q2 (1,7) Q3 (1,2) Q4 (1,6)
                 Q5 (1,7) Q7 (1,7) Q8 (1,6) Q9 (1,5)
                 Q10 TO Q18 (1,7)/ HISTOGRAM/
                 STATISTICS= MEAN STDDEV DEFAULT/
FINISH
```

Appendix F: Supervisors' Demographics, T-Test Results, and Open-ended Responses

TABLE X

Responses by Rank

RANK	FREQUENCY	PERCENT
MAJOR	7	17.1
LT COL	14	34.1
COL	20	48.8
TOTAL	41	100.0

TABLE XI

Years of Managerial Experience in Civil Engineering

YEARS	FREQUENCY	PERCENT
LESS THAN 1	0	0.0
1 TO LESS THAN 3	0	0.0
3 TO LESS THAN 5	2	4.9
5 TO LESS THAN 7	3	7.3
7 TO LESS THAN 9	5	12.2
9 TO LESS THAN 11	1	2.4
MORE THAN 11	30	73.2
TOTAL	41	100.0

TABLE XII

Method Master's Degree was Obtained

METHOD	FREQUENCY	PERCENT
AFIT/CI	19	46.3
ON MY OWN	12	29.3
OTHER	6	14.6
AFIT IN RESIDENCE	4	9.8
TOTAL	41	100.0

TABLE XIII

Research Option Used in MS Degree Program

RESEARCH OPTION USED	FREQUENCY	PERCENT
THESIS	16	39.0
NON-THESIS OPTION	10	24.4
NON-THESIS WITH EXAM	8	19.5
RESEARCH PROJECT	5	12.2
OTHER	2	4.9
TOTAL	41	100.0

TABLE XIV

MS Degree Requirement

REQUIRED	FREQUENCY	PERCENT
YES	29	70.7
NO	12	29.3
TOTAL	41	100.0

TABLE XV

Number of GEM Graduates Supervised

GEMS SUPERVISED	FREQUENCY	PERCENT
0	3	7.3
1 TO 2	6	14.6
3 TO 4	10	24.4
5 TO 6	5	12.2
7 TO 8	2	4.9
9 OR MORE	7	17.1
DO NOT KNOW	8	19.5
TOTAL	41	100.0

TABLE XVI

T-Test Results Between GEMs and non-GEMs

	GEMS	NON-GEMS		
TOPIC	M	M	t	p
Productivity	5.5000	5.2250	1.25	.220
Quality of Work	5.4500	5.2500	0.88	.384
Efficiency of Work	5.2250	5.1750	0.26	.800
Adaptability/Flexibility	5.4000	5.2750	0.61	.548
Overall Effectiveness	5.2564	5.2308	0.11	.916
Principles of Management	5.0750	5.0500	0.11	.914
Organizational Goals	4.9231	4.9744	-0.22	.831
Human Behavior	4.9500	4.9750	-0.10	.921
System Modeling	4.9440	4.5833	2.02	.051*
Financial System	5.0250	4.6000	1.83	.074*
Quantitative Techniques	5.0250	4.8000	1.14	.262
Minimal Guidance	5.3659	5.1707	0.88	.384
Informal Organization	5.0250	5.1500	-0.68	.499
Managerial Expertise	5.1250	5.1500	-0.09	.928
Plans and Organizes	5.2927	5.0488	1.14	.263
Problem Solving Capacity	5.1892	5.2432	-0.22	.824
Extensive Research	5.3659	5.0000	1.75	.087*
Writing Ability	5.3659	4.9756	1.71	.096*
Problem Solving Ability	5.4634	5.0488	1.93	.061*
Systematic Prob Solving	5.4000	5.1250	1.30	.202
Applies Knowledge	5.0000	5.0000	0.00	.999
Guides Employees	4.9189	5.0000	-0.33	.741

TABLE XVII

Most Appropriate Masters's Degree in Civil Engineering

DEGREE	SUPERVISOR	( ) Percentage GEM	NON-GEM
ENGINEERING MANAGEMENT	10 (33)	28 (64)	18 (47)
MBA	6 (20)	0	4 (10)
NO ONE "BEST" MS	5 (17)	5 (11)	7 (18)
MANAGEMENT (GENERAL)	3 (10)	5 (11)	2 (5)
TECHNICAL (ENGR)	3 (10)	2 (5)	3 (8)
CONSTRUCTION MANAGEMENT	2 (7)	0	1 (2)
INDUSTRIAL ENGINEERING	1 (3)	0	3 (8)
FACILITIES MANAGEMENT	0	2 (5)	0
CIVIL ENGINEERING	0	2 (5)	0
SYSTEMS MANAGEMENT	0	0	2 (5)
Total Responses	30	44	38

TABLE XVIII

Continue Thesis at AFIT

GROUP	YES	OPTIONAL	NO
SUPERVISORS	10 (27)	7 (19)	20 (54)
GEM GRADUATES	52 (48)	24 (22)	32 (30)

Appendix G: GEM and Non-GEM Graduates Demographics, T-Test Results, and Open-ended Responses

TABLE XIX

Responses by Rank

	GEM		NON-GEM	
RANK	FREQUENCY	PERCENT	FREQUENCY	PERCENT
1ST Lt	0	0.0	4	4.3
CAPT	63	58.3	47	50.0
MAJOR	23	21.3	29	30.9
LT COL	17	15.7	9	9.6
COL	5	4.6	5	5.3
TOTAL	108	100.0	94	100.0

TABLE XX

Work Section of Respondents

	GEM		NON-GEM	
SECTION	FREQUENCY	PERCENT	FREQUENCY	PERCENT
RESOURCES/LOG	2	1.9	5	5.3
OPERATIONS	16	14.8	14	14.9
READINESS	6	5.6	2	2.1
CONTRACT MANG	2	1.9	3	3.2
DESIGN	2	1.9	6	6.4
ENVIOR CONT PLAN	11	10.2	7	7.4
OTHER	67	62.0	56	59.6
MISSING	2	1.9	1	1.1
TOTAL	108	100.0	94	100.0

TABLE XXI

Sex of Respondents

	GEMS		NON-GEMS	
SEX	FREQUENCY	PERCENT	FREQUENCY	PERCENT
MALE	104	96.3	87	92.6
FEMALE	3	2.8	7	7.4
MISSING	1	.9	0	0.0
TOTAL	108	100.0	94	100.0

TABLE XXII

Age of Respondents

	GEMS		NON-GEMS	
AGE	FREQUENCY	PERCENT	FREQUENCY	PERCENT
25-27	4	3.7	7	7.4
28-30	24	22.2	20	21.3
31-33	31	28.7	14	14.9
34-36	10	9.3	18	19.1
OVER 37	39	36.1	35	37.2
TOTAL	108	100.0	94	100.0

TABLE XXIII

Undergraduate Degree of Respondents

	GEMS		NON-GEMS	
MAJOR	FREQUENCY	PERCENT	FREQUENCY	PERCENT
CIVIL ENGR	70	64.8	46	48.9
MECHANICAL ENGR	11	10.2	14	14.9
ELECTRICAL ENGR	8	7.4	6	6.4
INDUSTRIAL ENGR	6	5.6	10	10.6
ARCHITECTURAL ENG	1	0.9	3	3.2
ARCHITECTURE	4	3.7	10	10.6
OTHER	8	7.4	5	5.3
TOTAL	108	100.0	94	100.0

TABLE XXIV

Years of Managerial Experience in Civil Engineering

	GEM		NON-GEM	
YEARS	FREQUENCY	PERCENT	FREQUENCY	PERCENT
1 TO LT 4	17	15.7	22	23.4
4 TO LT 7	27	25.0	20	21.3
7 TO LT 10	28	25.9	24	25.5
10 TO LT 13	8	7.4	12	12.8
13 TO LT 16	10	9.3	5	5.3
16 TO LT 19	10	9.3	6	6.4
MORE THAN 19	7	6.5	5	5.3
MISSING	1	.9	0	0.0
TOTAL	108	100.0	94	100.0

TABLE XXV

Research Option Used in MS Degree Program Non-GEM

OPTION	FREQUENCY	PERCENT
THESIS	26	27.7
CASE STUDY	5	5.3
NON-THESIS OPTION	45	47.9
OTHER	14	14.9
NOT APPLICABLE	3	3.2
MISSING	1	1.1
TOTAL	94	100.0

TABLE XXVI

Statistics: GEM and Non-GEM Responses

NS: Not statistical significant	(Matching question in non-GEM survey) GEM	NON-GEM		
TOPIC	M	M	( )	p-value
8. Too much Theory	3.651	N/A	N/A	N/A
9. No Real World Appl	3.241	N/A	N/A	N/A
10. Writing Enhanced Knowld	5.278	5.093	(13)	NS
11. Prefer Add Course Work	4.537	3.556	(10)	< .1
12. Thesis Best Mtd Lrn PS	3.389	3.927	(11)	NS
13. Better PS (thesis)	3.861	5.430	(12)	NS
14. Non-Thesis Option	4.194	5.064	(14)	< .001
15. AFIT Ed Prepared EM	5.417	4.968	(15)	< .05
16. Recommend GEM Program	6.102	5.777	N/A	N/A
17. AFIT Ed Enhanced Prom	5.435	3.828	(16)	< .1
18. EM Best Deg for CE Off	5.176	N/A	(17)	< .001
19. AFIT Workload	4.389	N/A	N/A	N/A
20. AFIT Program Length	4.336	N/A	N/A	N/A
N/A Promotion better than GEM	N/A	3.602	(18)	N/A

TABLE XXVII

Best Method for Teaching Research

METHOD	GEM	( ) Percentage NON-GEM
THESIS	17 (27)	5 (12)
RESEARCH PROJECT	16 (25)	11 (28)
CASE STUDIES	8 (13)	3 (8)
RESEARCH PAPER	5 (8)	3 (8)
WHY TEACH "RESEARCH	5 (8)	7 (18)
TEAM PROJECTS	4 (6)	1 (2)
EXPERIENCE	3 (5)	1 (2)
"REAL WORLD" PROBLEMS	3 (5)	4 (10)
MORE CLASSES	1 (2)	2 (5)
SEMINAR	1 (2)	0
LAB RESEARCH	0	3 (8)
Total Responses	63	40

TABLE XXVIII

Would Have Preferred Taking Additional Courses and Completing a Smaller Research Project Instead of a Thesis

	GEM		NON-GEM	
RESPONSE	FREQUENCY	PERCENT	FREQUENCY	PERCENT
STRONGLY DISAGREE	11	10.2	1	1.9
DISAGREE	20	18.5	5	9.3
SLIGHTLY DISAGREE	5	4.6	3	5.6
NEUTRAL	8	7.4	10	18.5
SLIGHTLY AGREE	10	9.3	8	14.8
AGREE	36	33.3	14	25.9
STRONGLY AGREE	18	16.7	13	24.1
TOTAL	108	100.0	54	100.0

TABLE XXIX

Thesis Best Method for Learning Problem Solving Skills

	GEM		NON-GEM	
RESPONSE	FREQUENCY	PERCENT	FREQUENCY	PERCENT
STRONGLY DISAGREE	13	12.0	5	9.3
DISAGREE	28	25.9	11	20.4
SLIGHTLY DISAGREE	21	19.4	12	22.2
NEUTRAL	12	11.1	10	18.5
SLIGHTLY AGREE	21	19.4	8	14.8
AGREE	10	9.3	7	13.0
STRONGLY AGREE	3	2.8	1	1.9
TOTAL	108	100.0	54	100.0

TABLE XXX

Better Prepared to Solve Problems on the Job Due to the Thesis Effort

	GEM		NON-GEM	
RESPONSE	FREQUENCY	PERCENT	FREQUENCY	PERCENT
STRONGLY DISAGREE	12	11.1	4	7.3
DISAGREE	24	22.2	7	12.7
SLIGHTLY DISAGREE	7	6.5	4	7.3
NEUTRAL	17	15.7	23	41.8
SLIGHTLY AGREE	25	23.1	9	16.4
AGREE	18	16.7	7	12.7
STRONGLY AGREE	5	4.6	1	1.8
TOTAL	108	100.0	55	100.0

TABLE XXXI

Should AFIT Adopt a Non-Thesis Option
in the GEM Program

	GEM		NON-GEM	
RESPONSE	FREQUENCY	PERCENT	FREQUENCY	PERCENT
STRONGLY DISAGREE	16	14.8	5	5.3
DISAGREE	13	12.0	1	1.1
SLIGHTLY DISAGREE	14	13.0	5	5.3
NEUTRAL	11	10.2	25	26.6
SLIGHTLY AGREE	12	11.1	12	12.8
AGREE	29	26.9	28	29.8
STRONGLY AGREE	13	12.0	18	19.1
TOTAL	108	100.0	94	100.0

Appendix H: Open-Ended Question Responses

These responses were edited for grammatical errors only.

SUPERVISOR SURVEY OPEN-ENDED QUESTIONS

7. Currently the GEM program requires each student to complete a research thesis as part of the master's degree, this accounts for 20% of the academic requirements. Should the thesis continue to be required at AFIT or should a research project with additional course work be required?

Case by case based on the advisor and student with review/approval by the dean, i.e., the requirement should match or support the candidate and the objective. Answer the question "what meets the needs of the AF with regard to this student."

Research project with additional course work should be required. In my opinion, much of what is done as a "research thesis" is of questionable validity as thesis type research. Rather, it is more equivalent to "special project" or "research project" work. AFIT GEM program should use an applied research project, probably spanning 2-3 academic quarters (part-time), accounting for approximately 10-15% of total academic requirements.

Either can be effective - thesis probably considered more demanding and creditable.

I believe a thesis is appropriate for a master's degree.

The thesis is extremely valuable from a perspective of forcing a student to define and solve a problem. Also, it improves the writing ability of the student. A research project, in effect, can serve the same role by providing a comprehensive written report. The ability of the students to express themselves in writing, in a clear, logical manner is extremely important. Both a thesis and a research project can meet this goal if properly administered or defined by the faculty.

Research project with additional course work aimed at current management problems.

I believe there should be an option available to GEM students--either track should be acceptable.

Except for technique, the value of a thesis seems limited for engineering management. I would go with a research project with additional course work.

I believe a research project in the area of civil engineering management is most appropriate. By analyzing current CE policies and/or procedures, I believe the student can best prepare himself for future managerial positions.

It's a coin flip for what a student might get out of it. Less initiative required for additional course work instead of the thesis. Good advertising point for AFIT with thesis--great productivity improvements and problem solving ability.

Currently the thesis. A thesis is a valuable tool in that it forces the student to develop and defend a method to solve a problem. A thesis is a highly critiqued procedure. To successfully complete a thesis, a student must define the problem; research the background/obtain data/etc.; evaluate and re-define the problem; establish objectives; determine a method to achieve those objectives; perform whatever work is required to follow the method; and develop conclusions based on the work performed. This procedure is a highly structured system of logic and problem solving. It is a superior learning exercise that will apply to future endeavors.

Thesis work <u>does</u> have its place in a master's degree program. The research and report writing can be a valuable training/ educational experience for the student. Just as important, the CE community can benefit greatly from the findings of this process. Greater emphasis should be placed on thesis topic selection to ensure that "real" concerns are being addressed.

Continue thesis.

No, although some are useful, for the most part the thesis is of little value to solving Air Force engineering problems.

Prefer research project with additional course work.

Additional course work.

I feel a research project with additional course work would be more beneficial than a thesis. A broader background of studies will benefit the student more than the experience of writing a thesis.

I took the thesis so my opinion is prejudiced. I feel I learned a great deal while doing the thesis, not only about the subject but how to write, organize, research, etc. I think the thesis should be continued.

Thesis. A great experience.

I would like to see a research project that supports some of the research now being conducted at the AFESC laboratory at Tyndall AFB. Could even do some in-residence work at the lab itself.

Need option. Depends on study interest and capabilities.

I have seen the quality of some GEM research theses and have not been impressed by the magnitude of effort or research. It appears to be equal to an engineering report at this time. I believe AFIT should have a research project with additional course work.

Drop the thesis. Research project with more CE course work.

I favor a research project addressing real world Air Force issues.

I feel that the research project with additional course work is the way to go. We are attempting to get officers with more technical information/expertise not good writers (thesis).

Project o.k. Don't know if you need additional course work. Too much course work now. Maybe thesis with less course work or project with some course work.

Thesis - but no more surveys! Let's start seeing some real hardcore research on a practical problem whose solution will have immediate application to the field. (Take it from one who has lots of contact with E&S senior leadership--the field is about to rise in open revolt on these surveys. They are really tired of it and are starting to pitch them in the trash without even opening).

Make the thesis optional. If the student is going to a research or academic position, the thesis may prove useful. If he/she is going to a line engineer or management position, additional course work or research time would be more beneficial.

I think additional courses would be better time spent than doing a research paper/thesis.

Should be optional to accommodate desires of student/needs of the Air Force. A thesis per se is not necessarily a measure of a student's abilities.

Thesis - discipline of independent study and in-depth examination of a topic of interest.

Recommend the thesis be discontinued. I believe the students would gain more from a research project and additional course work. I have never found a thesis to be of value to me or my staff. Thesis out of date. Thesis did not consider cost/resources required to implement.

I feel a research project with additional course work would be more beneficial than a thesis. A broader background of studies will benefit the student more than the experience of writing a thesis.

It is important for officers to have experience (ability) to accomplish independent research, analysis which culminates in an organized written report. I believe the preparation of a full-blown thesis is excessive. A mini-thesis type of project is more appropriate.

A thesis should be required. However, not a thesis evaluating officers response to a certain topic - these are for behavioral scientists. The thesis should address an Air Force problem in engineering management or even more desirable a technical problem.

I would recommend a research project with additional course work or no project at all. The master's level is still too early to specialize to the extent a thesis requires. If you consider how our officers are employed (diverse situations and disciplines), the return to the USAF in officer effectiveness would be much better if we gave master's candidates additional courses (tools) to enhance the breadth as well as the depth of their potential. A thesis requires a lot of time in too narrow a field.

Research project with additional course work.

SUPERVISOR SURVEY OPEN-ENDED QUESTIONS

8. What is the best method of teaching students how to identify and solve significant Engineering Management problems?

Case studies.

I strongly advocate some form of case study approach.

Case studies, role playing.

Workshops. Group/team effort to solve given problem. Compare results with different teams and with actual solutions. Computer simulations.

Seminar - case study with oral and written analysis; peer critique.

In my opinion case studies - both from industry and military/government.

I don't know. Case study plus research on actual situation may be best approach.

Make them do research. Involve them in problem solving situations.

Give them a significant problem and let them solve it--lots of problems in the career field that require a solution.

Case study is one of the best methods for management problems.

Case studies, research projects, state of the art civilian world interface with industry. Detail applications in financing, personnel, and technical relations.

Usually through productive real world case studies.

Identify and solve significant problems. Working on real CE problems in school is a great way. Don't have to make a major contribution - just work on them.

Experience. Put them in the appropriate job so they can experience as many management challenges as possible.

Case studies combined with current approaches to management, finance, and corporate strategy.

Harvard case study method.

Provide the management theory then have students work case problems to apply theory. If case problems are taken from real situations, you can also show students what the "manager" did and whether it worked.

Provide the students with the knowledge and tools available to them. Regulations - learn basics and how to find information; human behavior - learn how to deal with personalities, how to determine who you can/cannot rely upon, how to get the most from people, etc.; logic, (how to differentiate between "fact and fiction," how to analyze the facts, how to use the facts in different problem solving techniques; management (including crisis management); self confidence; communications abilities). Apply knowledge to problem solving and management: thesis, case studies, role playing.

Examples of successful and unsuccessful solutions to a variety of problems.

Good question, I would suggest by comparing Air Force CE policies with similar private and public sector organizations.

I'm not sure I know--but I would lean toward case studies, along with several problem solving problems instead of a thesis or large research project.

Current case work problems based upon actual situations. Should focus on the impact of the present, and expanding reliance on computers.

Through application of real world examples that are <u>common</u> to most bases. Teach the theory and methodology then have them apply the tools to <u>real AF</u> problems.

Tough question. I believe <u>experience</u> is the best teacher since it takes time, case-by-case situations and good leadership to provide direction.

<u>Experience</u> is the best teacher - the hard part is gaining that experience without getting eaten alive for your mistakes. From the academic standpoint, you need to teach people how to <u>think</u>, recognize problems, and solve problems - skills that are often sorely lacking. The best academic experience I ever had was in operations research/quantitative methods - not because it taught mathematical techniques, but because it forced you to think in terms of structuring and solving a real world problem. I also suggest that a seminar/case study course taught by our very best, senior, experienced people would be of benefit.

Guided, tough experience.

9. What is the most appropriate master's degree for a civil engineering officer?

Any technical subject with a HEAVY emphasis on management.

There is no "one best" master's degree for a civil engineering officer. We need a mix of people with both technical (CE, ME, EE, Arch, etc.) and "management oriented" (IE, IM, GEM, etc.) degrees. For a particular individual, the most appropriate degree is a function of his/her particular skills, talent, ability, and personal goals and motivation. In very general terms, the best preparation for senior positions in our career field would be a master's in IE, IM, GEM, etc. However, individual skills, talent, and motivation are more important than the specific degree earned. Many people with master's or PhDs in technical specialties have been very successful as senior managers. Conversely, if by age 25-30, a person doesn't have some talent and motivation towards management, 12-15 months of "management school" isn't going to make the difference between success and failure.

Half hardcore technical and half management engineering.

Most appropriate master's degree for a 55XX is, without a doubt, the Engineering Management degree offered by AFIT. I am a graduate of '78 and nothing else compares to the education AFIT provides for a person who wants to make a career in 55XX!

Civil Engineering/Engineering Management

For most positions: management or some related, broadly-ranging "generalists" field--such as community and regional planning (my field).

Generally, engineering management or IE unless the officer is going to teach or do research, then specialization would be appropriate.

Facilities/systems management.

One that prepares him for his next assignment. P.S.: GEM graduate was two-time passover to major, separated from active duty in April 88, hired on in CES as GS-11 Environmental Planner/Engineer, joined reserves as Prime BEEF officer. Non-GEM graduate would not have made it in AF and separated from active duty in April 88 as well.

Construction management with minors in financial management and human relations.

Don't think the question or answer is that simple. Many CE officers will be in management positions and a GEM degree would be better. However, we also have requirements for CE officers in research, instruction, and other heavily technical positions. Here, a non-GEM degree is needed. Bottom-line, we need both programs.

Engineering Management.

MBA or master's in public administration.

Structures or soils - technical.

A master's in business management.

For the 55XX career field, a management related degree. NOTE: In this isolated case, comparing on officer to another, is not a valid comparison for GEM vs non-GEM. The two have different aspirations and mental capacities. Both are outstanding.

GEM or MBA.

My master's is in construction management and it has served me well. A technical oriented master's would only be used early in an officers career. Need a program which addresses Air Force CE management problems and techniques.

Industrial Engineering.

Sounds like a trick question. Appropriate degree has to be driven by the needs of each job. In most cases I don't think a master's degree in an AF civil engineering officer is necessary. But if we really determined that a master's was needed in most cases an engineering management degree would be appropriate.

There is <u>no single</u> "most" appropriate MS degree. Our functional area is divergent.

Engineering Management/MBA.

Management of some sort. Civil engineering officers need the technical undergraduate. The future for the civil engineering officer is <u>not</u> designers but managers.

Job dependent. No one appropriate degree. How many sub-disciplines in CE? Arch, EE, ME, CE, IE. What job does he/she have? What career goals? Academic (USAFA, AFIT)? R&D? There is <u>no</u> "most appropriate" degree. I

realize you would like me to say a management degree since all officers have to manage - but I don't think it takes a management master's to do that. Look at Gen Goodwin (PhD structures) or Gen Harty (PhD structures) or Col Allen (USAFE DE-2, PhD Soils) to name a few. Lots of others with technical MS degrees serving in DCS and Air Staff jobs.

Engineering management - non-technical - avoid specialization for senior level jobs.

There's no one best degree. We need some people with technical master's and some with management master's. Not all officers need advanced degrees.

Engineering Management. I don't think a master's in CE does much good at a time when officers are getting out of the engineering/design business and into leadership positions.

Generally management/business with a few technical.

Management/Business Administration. A field grade civil engineering officer is a manager. Emphasis should be placed on understanding computer basics due to WIMS.

A master's in Business Management.

Program with a mix of management and technical course work. I believe programs such as "engineering-management," "systems engineering," construction management, "industrial engineering" should be the norm. However, there is still a need for some technically oriented programs - but they should be the exception.

A technical MS degree in either structures, soil mechanics, environmental, or construction management. Officers in the CE career field without technical master's degrees cannot properly analyze the technical problems they must solve and usually make poor decisions. If we continue to de-emphasize the technical aspects of CE, our air base infrastructure and readiness capability will be degraded!

That really depends on the needs of the USAF. I have worked with all levels and types of advanced degrees, and they are all necessary to the mission. Across the board, I would put more emphasis on management, but we still need capable people with advanced degrees in structures, soils, civil, and water to work in our more technical locations such as labs and the SPOs.

GEM SURVEY OPEN-ENDED QUESTIONS

21. Currently the GEM program requires each student to complete a research thesis as part of the master's degree, this accounts for 20% of the academic requirements. Should the thesis continue to be required at AFIT?

Not necessarily - perhaps optionally. In its absence, however, writing and research within individual courses should be required. Too many officers working for me do not know how to do problem research nor write. They are terrific engineers but can't write a simple letter or solve simple problems. In today's force, being only a good engineer is not enough.

I graduated from the Space Facilities program. The thesis requirement should be returned for courses that are highly technical. For management courses, I'm not sure. Case studies which require some research would be an alternative. I still like the idea of thesis requirement.

No. Many students do a thesis in the interest of "filling the square". Even though their advisors sign off on it, it doesn't add to the overall corporate knowledge of the AF.

I'm proud of the hard work I put towards the thesis and there is a sense of pride when you say "yes, I had to do a thesis for my master's degree." So, all in all, I'm glad I did it. However, I think 80% of the class did the work as merely a square filler. They were not really interested deeply in their topic. As such, the work becomes a drudgery and one takes shortcuts. Too many of us looked for a thesis topic rather than had a burning question we were anxious to answer for our selves and the AF. Answer: Yes, but maybe find a better way to choose topics.

Yes - it teaches students how to thoroughly research a problem. (Although people in the real world would rather not give you the time to do things right).

Yes, especially if the topic is relevant to the very next career step. The time and understanding gained from the research is valuable beyond belief. Having graduated five years ago, I now wish I had spent my thesis effort on environmental pollution. The point is, that this is a unique career opportunity to become much more knowledgeable of a subject than at any other time in your military career. The actual writing/rewriting is not as valuable, however. If the Air Force wants the style of writing changed (we paid in time and $ for our thesis) they should foot the bill for it.

I think the thesis should be optional with the student deciding whether to do the thesis or additional class-work.

As long as valuable research is gained, if no benefit is gained for practical application of the research to solve real world problems then it should be discon-tinued.

Definitely! The thesis is a very meaningful experience and a powerful learning tool.

Yes and 20% sounds right.

No, give the option to take more real world application type courses.

The thesis process is one of several excellent educa-tional vehicles--it is not in and of itself the best or most appropriate vehicle in all situations. Some topics can be properly addressed in using essentially the same thesis techniques in a comprehensive term paper or series of papers. I don't feel that a thesis require-ment "makes or breaks" a master's program--the quality of the learning experience (however structured) is the key determinant.

Yes. It doesn't help in problem solving, but it was effective. My thesis did not apply only to CE areas as they do now--a good change.

I believe the thesis requirement can be dropped without sacrificing the quality of the GEM program. There are only a handful of positions which require a thorough knowledge of the research process. Creative solutions to a variety of core studies may serve the career field and the graduate in a more useful fashion.

Yes, this was the most demanding but rewarding part of the program.

Yes, I believe the thesis should continue as an AFIT requirement. My thesis work taught me basic research/ management methods, but also, and more importantly, it honed my organizational and writing skills. These skills are the ones I've found to be most valuable in my AF work since completing AFIT. Engineers need to have good communication skills, and should be able to manage a nebulous, long-term project, and the thesis is an excellent learning tool for these skills.

Yes. With a thesis you learn much more than just research and problem solving techniques. You learn how to present findings and conclusions in both written and oral form. You learn better writing techniques. I feel that replacing the thesis, which is at worst an outstanding simulation of practical problem solving and at best provides useful work for the Air Force as well, with more theory classes would be a serious loss to AFIT and the Air Force.

The thesis should be optional. I recommend 3 option programs. Option 1 includes present course curriculum with thesis. Option 2 includes group project research. Option 3 would offer additional courses in lieu of thesis or group project. NOTE: Option 2 would be a small group of 2 to 6 students who would do a research study to solve a real problem in DOD, and would be guided by a faculty advisor. This would allow AFIT to offer DOD its services as a "think tank" and consulting service.

No - I estimate 75% of my time related to thesis work and was spent typing, correcting same, and complying with associated administrative BS. The only benefit I obtained from my thesis work was a slightly increased typing rate.

I believe the time could be better applied with more emphasis on practical Air Force applications.

Yes. I learned a lot from doing one. The actual process was terrible, however, the thinking process was excellent. Going through the process was well worth the agony. It helped me to understand the thought process not just the theory.

Absolutely. Teaches thoroughness and makes you set milestones to complete work on time. Best and hardest part of graduate work.

In hindsight it is easy to say everyone should do a thesis, because you finished yours, but I think the Logistics school should add more course work and a smaller research project, or all course work like civilian schools. For some the thesis is incredibly difficult and cumbersome.

No. More variety of course work would be more beneficial.

Yes. Thesis type research may not be done at base level very often, but at staff level jobs many "studies" are done. Some are technical studies (lab and field) while others are managerial. Whether the GEM graduate

performs the research or reviews it, having been through the process once and knowing what to look for and which questions to ask is an invaluable asset.

No. Offering options of thesis, or equivalent numbers of semester hours course load should suffice.

Yes. The discipline in time management, logic, and english are especially valuable to engineers - those of us who typically never get such opportunities when we obtain our BS in Engineering.

Yes. Besides learning how to carry out research, the thesis effort allows students to experience the completion of a large, detailed, complex project. Precise writing skills are learned. I learned to write exactly what I meant. I felt a sense of pride when I completed my thesis. Furthermore, AFIT theses fill a vital role in learning more about topics vital to USAF Civil Engineering. More direction should be applied to GEM students to ensure their theses meet the needs of the USAF CE community.

The process of writing a thesis is enlightening: gave me an appreciation for research, what constitutes research, and Dr. Fenno's dilemma with Air Force lieutenants. But, the cost (time, student benefit from the endeavor) does not now sit well with me. At the time, I had no argument against the thesis that would be perceived as other than sour grapes or just plain bitching over a tough task that needed doing. Now, I think time could have been better invested.

Yes. The thesis is not the best method for learning problem solving techniques; however, it does provide you an understanding of how to use background data in presenting policy changes to commanders. A thesis effort prepares an officer for understanding the importance of research support for staff officers.

No, it becomes a square-filling exercise.

Yes. Research techniques learned as a result of the thesis requirement are invaluable. Problem definition and a well planned methodology are critical, not only to problem solution, but to communicating the problem and proposed plans of action in the real world.

LONG ANSWER (my preferred response): I learned a lot from the process of accomplishing a thesis. However, what I learned was not about the research process, but more about reporting and writing accurately. Consequently, if the sole goal of accomplishing a thesis is to teach the research process, I believe the thesis

should not be required. The research process can be taught in communications classes just as well by accomplishing additional short papers/reports. (NOTE: I believe COMM classes must be longer and receive additional emphasis - i.e., credit). Additional time could then be spent on either electives or additional core courses. I will concede an exception to what I've stated above. Namely, if a thesis is necessary to maintain the credibility of an AFIT master's and the AFIT program in the eyes of other institutions, then I would say keep it. SHORT ANSWER: no.

A thesis which addresses a well documented issue/problem can be of significant benefit. However, a vast majority of theses I'm familiar with address obscure topics not applicable to accomplishment of the mission of our career field. They are written solely to meet the academic requirements for graduation. Therefore, I have to say theses should no longer be required at AFIT. I think the time spent on a thesis could be better spent taking additional courses or preparing smaller scale research projects specifically oriented to problems common to leaders/managers in the Civil Engineering career field.

No. I support a non-thesis option which would include an advisor-guided research project. My only apprehension is that, over 6 or 7 years, the projects and theses would begin to look alot alike (i.e., diluting the theses).

Yes. Regardless of the increase in classes, the value of the thesis cannot be compensated for by taking additional courses. If the requirement is taken away, an important aspect of the AFIT program is gone. Let's face it, very few people are going to have trouble taking and passing the courses. The thesis is the only thing that really requires 100% effort, and for me it is my proudest accomplishment in the program. I may not be expressing my thoughts well, but what I want to get across is the fact that the program won't be the same without the thesis requirement.

I don't believe I benefitted from doing a thesis as part of my master's program and I do not believe it should be continued AFIT. The 20% attributed to the thesis should be directed to other courses that might benefit the engineer professionally or towards actual problems being encountered in the Air Force. In the latter area, there might be efforts towards revamping certain forms (i.e., work requests (AF Form 332), DD Form 1391/1391c (project documentation)) that we use in day to day business; another possibility might be in the disparity from

command to command of how we develop space requirements using AFR 86-2.

Yes. A lot can be learned from a thesis effort, most notably the "research process". Plus, the AF benefits from information gathered on what is typically a CE-related matter. I hated doing a thesis, but stepping back and taking an objective look, it was a worthwhile experience and contribution.

Yes. If for no other reason it teaches the use of logic and significantly improves the officer's writing ability.

No. The time could better be spent with several more technical courses.

I think so, as long as useful products are produced. But I don't feel that should be the only option. Other research may be more valuable.

No. 1) it should be optional; thesis or project or extra courses; 2) whether the thesis is mandatory or optional, it should not be restricted to a "one-person" effort. A "two-persons" thesis greatly enhances the process and achieves better results. NOTE: Theses are just "eye-washes" - some were about 40 pages long, others were completed in less than three-four months. All were accepted. Why not do a project instead.

I have mixed feelings concerning the thesis. I strongly believe that a thesis is ideal for learning the proper techniques of research and how to report that research. However, some problems in Civil Engineering could be solved and/or researched without performing a "complete" thesis. I believe some research topics are not addressed because the students fail to recognize how to generate a five chapter thesis on the subject. Possibly by adding some flexibility to the thesis structure would allow students more opportunities in the topic selection area. Requiring only thorough background research of the problem for the first chapter and allowing students the flexibility of reporting their results as they deem appropriate for the remaining chapters would be adequate for the GEM program. Still provide instruction on how to validate the results of the research but don't limit the students' creativity by making them follow established thesis guidelines.

Definitely. It enables the student to identify a problem, break it down into specific areas, research past attempts to solve the same problem, identify and recommend solutions. In other words, it forces one to think things out instead of just reacting.

Not necessarily. It is not something really beneficial or related to the jobs we will be dealing with in Civil Engineering. Neither are the skills utilized in writing a thesis beneficial. Civil Engineering demands quick concise and complete responses to real life situations.

I think a research project would fulfill the requirement. Students should still be taught the research process. It is hard to do a good thesis in the time constraints.

Yes, a valuable lesson in initiative, self motivation, thought process - as well as research.

No, I feel there was too little support from the field. By the time an AFIT student finished the research and published the results, the issue was, generally, no longer important. Recommend AFIT develop a doctorate program in EM and have the thesis work done there.

Yes. However, more guidance should be given concerning topics and more discretion used in approving topics. A lot of theses are accomplished to fill a square and are of not much real benefit to the Air Force.

Many things are learned in doing thesis work. Among the primary things are: reading, synthesizing, writing and thinking. These skills are critical to CE officers, they are often skills passed over. These skills could be taught through other methods if those methods were closely monitored. PS: When I did my thesis, there were two of us working on it. Consequently, I probably only learned half of what I should have. Even then, it really helped my dissertation.

If the thesis process is properly conducted the students will greatly benefit. Problems I perceived with the process in 1982 are listed below: a) subjects were not restricted to engineering related topics; b) the definition of thesis work was far too restrictive, which made it difficult or impossible to address non-academic, real-world problems; c) more effort needs to go into the grading process. Weight should be given to level of difficulty of the thesis. A teacher/thesis advisor should not independently slap a grade on a thesis without the benefit of extensive guidance on grading. The students put too much work into a thesis and the thesis carries too much weight in grading to allow a haphazard grading program.

Either keep the thesis or add a couple courses and a research project. The idea of thesis/research project forces a person to organize and put forth some original thinking - forces a certain level of self-discipline.

The GEM thesis requirement should be made an optional part of the master's degree. Many of the available research topics are either too broad or require an effort far beyond the scope of the AFIT program. The requirement of one student, one thesis does not allow for the level of effort to adequately study Air Force problems. As a consequence, many of the studies are just block fillers with little application or interest to the real world.

A thesis has its merits, however, I favor taking more courses of "stuff" I want to take or I feel are interesting, rather than doing a thesis. There were quite a few courses I would have taken in lieu of a thesis.

No. Our job in Civil Engineering is to 1) be prepared to go to war and 2) provide a service. Typically, there are relatively few opportunities in CE to apply the statistical knowledge I acquired while working the thesis. The thesis didn't help me translate the knowledge acquired in the AFIT classroom into real world/Air Force applications.

Yes, but the graduate facilities engineering program (not management) should be brought back. This program lasted only 3 years (74-77) and the slots were transferred to LSG. The graduate facilities engineering program was taught by the AFIT School of Engineering and contained much more academic rigor than the current GEM program.

Currently, the thesis counts for more of the grade than when I attended. It was too much then. There is much too much effort required on the thesis for the academic benefits achieved.

Not necessarily. Added course work, I believe, can be as beneficial.

Thesis should not be required. Students should have the option of additional course work and/or research project.

Yes - it will help the degree maintain credibility.

The thesis is a mixed bag. A good number of civilian institutions do not require such, which leads one to question its worth. On the other hand, completing a thesis gives one a sense of accomplishment and permits one to learn in-depth about a particular subject. It also is a rigorous application of problem solving techniques. I feel quite proud I completed a thesis

even though it probably doesn't pass the "so what test." I would not, however, want to do such again.

Yes. It represents a typical situation you may/will encounter in actual job.

I think we need theses to help sell benefits of our own advanced degree program in-house. We do theses for ourselves to solve our own problems.

Sure, lots of people don't like it because "you have to think" - organize, synthesize information. Its tough. Doesn't make it bad. USAF needs capable thinkers.

Absolutely, it is no fun to do but the research, writing and organizational skills learned are invaluable.

I do not feel that the thesis contributed a lot toward my education. Would have benefitted more by taking additional courses.

Definitely yes. I feel the most benefit you get from writing a thesis is that it improves your writing skills and teaches you how to organize a large amount of information and then present it in a clear and concise manner. My thesis work really helped me be a much better officer when tasked to do involved staff work/studies. My bosses have told me they felt I was much better than my peers when it came to writing staff summary sheets, background papers, point papers, and other related studies. I think doing a lengthy thesis had a lot to do with improving my skills.

Definitely. There are lots of spinoffs: 1) channels research into current CE issues. Focuses GEM efforts to current problems. 2) provides research to solve other issues throughout AF.

No. The thesis becomes nothing more than an <u>English</u> project. The topics are usually <u>bogus</u>, the results <u>useless</u>. Also, we never have time in the field (and it will get worse) to do any actual research. Therefore, the research methods we learned are not applicable to real life AF.

I think AFIT should keep the thesis requirement. Having to do a thesis makes your degree more creditable. You are looked down on in the academic world if you didn't do a thesis in your master's program.

No ... should be an optional requirement. From my experience, the thesis work was about 35% research effort and 65% administrative.

Yes, but I think it should be a research effort for more than one individual. Maybe it could consist of 3-6 individuals concentrating on a team effort on a larger scope project than what one individual could do.

Yes - as a commander and as a staff officer at AF/LEEC, I am appalled that so many of our professionals - civilian and officers alike, cannot address a problem in writing. When interviewing a potential job applicant, I always ask to see a sample of their writing ability.

I don't think the thesis effort should be continued. Only one or two theses per year really make a contribution to improve Civil Engineering. I think the Air Force officer would benefit more from courses like Federal Financial Management (optional in Class of 83) and other courses that explain how our Air Force and government work (the big picture). The thesis taught me how to tackle a big project and break it into small pieces and get it done. I learned a lot personally but doubt if very many people have even checked my project (I'm afraid to look).

No. The thesis should be optional. Students should be given a list of topic areas that the AF says need study and if one strikes their fancy, they should be allowed to do a paper or study on it. Otherwise, include additional course work. NOTE: The technical writing course that was a preliminary to doing the thesis was a very worthwhile course and has helped significantly in explaining complex issues in laymans terms.

Yes. A thesis is a critical part of any quality master's program.

The masters program I attended was the Civil Engineering Facilities program at the School of Engineering so I can't comment on the GEM program. On theses in general, it's my opinion that 20% of academic requirements is too high.

No. If the reason for the thesis is to learn about the particular topic selected or add to the store of knowledge about a particular topic, I'm not sure it succeeds. That topic should be related to management of engineering and its tough to get too practical in the academic environment on that subject.
I believe that at least in the case of the GEM that an alternative should be offered - i.e., taking equivalent credit courses in the engineering technical area at the AFIT Graduate School of Engineering, etc. However it should be an optional alternative - individuals could still do a thesis - if they desired and <u>hardcore</u>

research topics existed that would enhance Civil Engineering productivity or performance.

No. Although a benefit in enhancing one's ability to "articulate," not problem solve, and confront "academic" principle to prepare a document, the time spent working a thesis project could be better gained in boarder subjects.

Yes, but possibly not as much of the requirement.

Yes, the thesis forces the student to logically communicate the knowledge he has learned to others. The skills learned during the endeavor are directly applicable to the written communication requirements of an Air Force civil engineer officer/manager. The thesis topics must remain focused on Air Force problems in hopes the research process will assist in identifying solutions.

Hard question. I believe there's great value in doing research. The most difficult problem is selecting a worthy topic. I would leave it as an option for those who have a desire to do it, but provide alternatives such as extra course work with pre-selected research paper topics. I would also make current research more available to the field. A lot of good stuff is done, but no one sees it.

Either a thesis or major project should be required - but put emphasis on: 1) problem solving; 2) having the GEM become an "expert" on his/her thesis/project subject. Don't put so much emphasis on: 1) research outcomes/findings; 2) usefulness of thesis findings in CE. We got paid to <u>solve</u> CE problems and for being the expert on CE matters - not for our academic research findings.

A thesis can be worthwhile however the student can spend more time than is appropriate on format and simply struggling with a not well defined topic. A series of shorter papers could develop the same research skills without wasting a tremendous amount of time on a poor topic. Theses however do build character.

Yes - I learned so much more from completing a thesis, in an area I selected, than taking 12 more credit hours could have provided. Actually, once I "got into" my topic, I enjoyed it.

I definitely believe the thesis requirement should be continued. I further believe the students should demonstrate the capability to orally defend the findings of their research project. The thesis option should

continue for those who want it. However a non-thesis option should also be available to students. I realize that most students would probably choose the non-thesis option, but I'm not sure the thesis requirement currently in place really serves the purpose for which it was intended. The time limitation at AFIT makes it difficult to do a thorough job of research and problem solving.

Thesis requirement should continue to be included in the GEM program. The knowledge gained by the individual in area of problem definition can prove invaluable. However, I recall individuals treating it as a paper exercise. The mechanics of how the project (thesis) is developed should be closely tied to some form of presentation to peers to challenge the individual and his perceptions (i.e., round table with short course personnel, etc.).

Neutral. Academia professionals should make this decision - possibly it should be optional - thesis or more courses.

No, generally a thesis does not improve one's managerial skill or knowledge base that would tremendously benefit the individual when he "re-enters" the service. The availability of additional courses would be more beneficial.

I would prefer an option. I thought the time I spent on the thesis (especially stuffing envelopes, typing, etc.) would have been better used by taking some of the AFIT electives that appeared interesting/useful.

Yes, the thesis, while giving me a terminal case of ulcers, forced me to work and strive as no other effort ever has. It forced me to sort things out in a precise and logical manner, to understand the need for proper format and English, to see the value of real research. I have, and will continue to use many of the lessons I learned from that grueling effort.

22. What is the best method of teaching students how to do research?

Make them do it. There is no teacher like experience. With an appropriate introduction in research methods, analytical statistics and English/research preparation, and a kind and understanding advisor to keep them pointed in the right direction, let them go and they shall learn.

The same objective may be met for the most part by having a smaller research project.

Most students already have this capability through undergraduate requirements. Otherwise, doing research papers or position papers.

Experience ... is it required to know how to do research?

When properly challenged the thesis is a valuable tool. But when it becomes a square filling exercise (as is the case in many instances) much of the value is lost.

The thesis certainly is a good method of teaching students to do research, but a problem solving project on a smaller scale than a thesis could also serve that purpose.

In order of preference: 1) do the research--identify the topic, structure the study, gather the data, analyze the data, report on the findings, endure thoughtful/constructive criticism during the process; 2) help someone else do research; 3) monitor the research process; 4) read about it; 5) think and talk about it.

Provide suggested areas of research (that are "researchable" and can generate data) from which to choose. Match up a thesis advisor with the GEM student early in the program. Talk about previous work in the area and research methods that have proven successful (and unsuccessful).

5 to 15 pages would do well.

Research methods seem to work o.k.

Teach methodology, of course, then give them a topic or question to research. You must include application through either a thesis or research project of smaller scope.

Concentrate on teaching logical problem solving/analysis techniques and strong communication skills.

Why do we want to teach "students" to do research? Definition of a "student" should be separated into two endeavors: academic pursuit (R&D or staff careers) and operational decision making (line officers). Research is needed in R&D type environments. Ability to gather and analyze available information is needed in operational conditions.

I believe the total course load - now teaches adequate research techniques and would do so even without a thesis requirement. Various courses require extensive outside research and written papers currently.

A series of problems which give multiple attempts at experiencing the problem solving steps.

The thesis is probably the best way to accomplish this objective but shouldn't be mandatory or the only way. It could be done by narrowing in on a very specific topic as part of course work in a specific major. Too often academia makes a student select a topic for a thesis that attempts to cover a broad spectrum of his course work thereby diluting the thesis and making it a large and tedious effort with no significant result.

Classroom instruction followed by actual thesis preparation.

Ask the basic question first: Do all of the GEM students need to know how to do research? As a BCE, I certainly don't have time to allot to research as it was taught to me.

The small papers (8-15 pages) we did by the dozen every quarter were adequate lessons in research. An officer needs lessons on delegation, management and leadership. We need to know more about how to motivate and understand our people. I don't see research as important as these other things.

Small research projects with varying requirements and levels of difficulty separate from the thesis.

A thesis is suited for research, but team involvement would enhance the quality and thought process afforded a project.

Course work with possible <u>small</u> research project.

Some structured course work with a number of medium length research papers covering different topics.

Teach the research method, but teach it in a format we will use. That is, we need to know how to research things, but our time is limited. Therefore, researching smaller projects than a thesis would be more applicable. Something along the lines of Air War College type papers.

Start with small research assignments and gradually increase depth and scope.

Have a research methods course (you do), give an advisor, a problem, and learn by accomplishing research.

Theory - example - do it - feedback.

Several shorter, smaller research projects, to include at least one staff study.

Other than attempting to teach hard, objective analysis of issues/situations, I've drawn a blank.

A prepatory class.

Completing a research course along with several research projects.

I am going to play politician and talk around this. Is AFIT trying to teach us how to do research or be a manager? I thought it was how to be a better manager. I think too much emphasis is placed on the thesis, although I was glad to see it only accounted for 20% of academic requirements.

If teaching research methods vs management techniques is the objective of the AFIT GEM program, then for each group of 5 or 6 students a single research project should be required. A group of students doing research on a single subject would produce a far more useful product. The greater depth of a project would enhance the level of understanding of all the students.

Establish the basic skeleton involved with the process. As the year progresses, walk them through the process with deadlines for certain products involved in that process.

Research reports, background/position papers on actual CE problems. Close the gap between research process (long term) and actual need (now). I use the research process frequently, but in a much abbreviated form.

Writing a thesis - but one of importance - I don't know if surveys (involved with thesis) teach a student anything - i.e., research should be directed at an engineering (real world) problem.

In 1982 I believe the thesis program was significantly misguided. A good thesis program with a good compliment of other research papers and writing assignments is the best method. However, the students must be required to perform research directly related to engineering management; the thesis process should be opened up more than it was in 1982 so valuable, real-world research can be performed; and put more effort in the grading, so students are appropriately rewarded for dedicated and hard work.

Doing it is the best way. Talking about it helps. Small reports and research papers are good too. Reading about it is the least effective method.

Hands on. Do two theses. The first one would be of smaller scale with the purpose being indoctrination and familiarity with the process. The second one would be of larger scale with the purpose being a quality product that will benefit the Air Force.

Offer it during the intro portion of the program along with Intro to UNIX, etc. Then have the students apply it through a series of research papers and briefings.

Classroom and then use projects to apply principles learned in the classroom.

Almost all Civil Engineering problems are not done alone but in a group format working with other Civil Engineers or A/E contracting firms or with other Air Force personnel at base or MAJCOM levels. Skills related to teaching this would be "real" Air Force research.

Writing papers on "smaller" problems in various courses (Mgt Info Sys, etc.). The thought process was similar to the thesis effort, only limited in scope. Recommendation: stick to less than 3 people per project. 2 is ideal. More than 3 is a waste.

Beating it into their heads? I don't know. What methods did you have in mind? What kind of research? What does research have to do with being a CE officer? How can I use research on Prime BEEF?

Through a technical paper.

Elimination of survey technique, have students work real CE problems. Labs are available on Wright-Patterson, the computer is a good source of topics and thesis effort. I guess I'm saying work real world CE problems.

Nothing can replace the "pencil to the paper" approach.

Let them work those day-do-day problems that come up in our business all the time. Generate a P-341 document on something that is downward directed from HQs (which we know little about but must become knowledgeable in a short time frame); work up position papers/strategies on dealing with the local civilian community on 801 (build-lease) housing initiatives; or, take a stand on an encroachment issue that threatens to close down a portion or the entire base operations. In other words, something that they'll be dealing with at some point in their career.

The best way is by doing. Thesis is probably tops. The research method class was good, but it's forgotten if it's never applied.

I'm no teacher myself, but the thesis worked for me. My only inflexibility is that alternatives to the thesis include some form of research by the student. It's best to learn by doing.

Short papers on subjects already thoroughly researched. Student would receive topics and conduct their research and present a paper documenting their research. Instructor could critique the student on his research process by reviewing bibliography and paper content against the "standard" (the thoroughly researched report). I would suggest such things be done pass/fail. Also instructor could critique writing style, format, accuracy in writing, etc.

Smaller research projects with specified courses. AFIT theses have a bad image (and mostly true) that there is no application to the field. Make real world research projects with some of the class-work.

Term papers in preparing for a thesis effort.

Reiterate what engineers have been doing (should be doing) since their early days in college: assess the knowns (current literature, policies, practices, or "givens"); determine requirements (to resolve particular problem, narrow the scope); make assumptions (best procedure, applicable problem solving techniques); "crackout" the solution.

Sic Dr. Fenno on them. Seriously, the research methods course does a great job of teaching how to do research. Don't change a thing.

Do it, write it, receive graded feedback. The mini-, midi-, maxi- process, if still used at AFIT, helped me crawl, walk, run.

Why do you ask? It seems to me, both high school and undergraduate work do this task fairly well. I do not subscribe to the assumption that I was taught how to do research while at graduate school. If we want research specialists - then lets offer a study specialty area - if we want civil, electrical, mechanical, etc. research specialists, we will be able to hire them - I see no wartime need.

The best method is doing it. Small research projects/ papers in early courses are a great lead-in to the thesis work. Getting a feel for research methods and their limitations early can save a lot of embarrassment and late nights on the actual thesis itself. The business research methods class deals with some of this, but other courses should incorporate some minor research projects to help student get a hands-on feel for different types of research.

The ability to do research has very little to do with how effectively a civil engineering officer (or any officer) performs his job.

Have them do smaller more well defined, time bounded projects.

A thesis, however few engineering managers need to do formal research - they need to know how to use the library, research regulations, and organize a position.

Students should investigate specific, more narrowly defined topics relating to engineering management or the military. The research period should be a 2 quarter exercise at most. The time wasted preparing and processing questionnaires, for example, could have been spent studying topics related to engineering management in the military.

Research methods course <u>teaches</u> students how to do research. Thesis, group project, etc., allows students to <u>demonstrate</u> this knowledge.

I'd recommend a combination of smaller "research papers", to teach specific research methods (similar to the projects done in the communications courses) and the

thesis, to incorporate all the various aspects of research technique.

Why are we, or should we teach how to do research? Is research required for a base level CE position? Certainly, the best method to teach research is to guide students through an intensive analysis of a specific research question, i.e., a thesis. However, for the CE career field, maybe the case study approach suggested above may be more appropriate.

The ideal method would probably be the thesis process given sufficient quantities of research material,, time, and research support (computers, clerical staff, etc.) In some cases, these resources are not always readily available in the AFIT environment for chosen problem areas/topics. In such situations, students should have the flexibility to experience the research process in a series of papers addressing portions of the process. Unfortunately, this alternative to the thesis doesn't provide the entire learning experience of the thesis research process, but it will expose him to the essential elements of research to enable him to apply it on the job.

More short subject papers dealing with real problems and not theory.

For me the thesis was a fill the square and graduate effort, I did not learn a lot about research. What I did learn was mostly picked up in classes. I think the necessary skills for research could be provided through classwork.

I must admit that I learned a lot from my thesis about research. I think it depends on how rigorous one's advisor is. For me, the thesis effort was the best method for teaching research. I believe it all stems around individual differences, thus the need for an option. Hopefully, the student would then pick the learning method most comfortable to him.

23. What is the most appropriate master's degree for a civil engineering officer?

In this business it's engineering management. Our goal is to be able to run the business of Air Force engineering and services. It is big business. It involves big bucks, big decisions, big risks, and big politics.

I believe a MS in Civil Engineering, particularly in construction management, would have better prepared me for the career field.

Management.

Engineering Management. But the organizational behavior courses were a total waste as were the research principles.

Engineering/facilities management.

Engineering management - very little need exists for a hard core technical degree in our current mode of operations.

The answer depends on the goals of the officer. If management is the aim, then the GEM program is as good as any. However, a program such as an MBA with more emphasis on financial management is as good. For some engineering officers a technical master's is best.

The one most closely akin to the role in which he will predominately function. In most cases, the graduate degree in engineering management is excellent.

GEM was a superior program simply because the curriculum is appropriate for CE officers; more so, I believe, than a technical master's degree.

There is no "most appropriate". Our career field needs both management and technical expertise. However if we could only have one, a management degree would be it.

GEM, GFM.

Engineering management. Technical expertise can be bought through the civilian sector. CE officers must have enough technical knowledge to recognize inaccuracies and problems. But the real need is to manage/lead others to resolve the problem.

Depends on level and rank. Younger officers - more technical; major and above - management.

Depends. For those that do not branch out into teaching (i.e., AFIT, USAFA) or where a specialty is required (i.e., structural analysis, construction management) then a degree in engineering management is the "most appropriate."

In most cases the GEM curriculum. However, we do need some officers to get technical advanced degrees - i.e., civil engineering, electrical engineering, etc.

Obviously engineering management. How many 55XXs do anything else after captain?

Engineering Management without a doubt. No matter if you're working at base level or on a staff, we're all doing the same thing, managing engineering resources.

A degree in facility engineering with additional management courses would be of greatest benefit. This will allow you to know enough about mechanical/ electrical/civil systems to keep yourself out of trouble. The management courses will help to manage your assets.

No such animal, GEM was best for me because I am a manager at heart. Technical master's (and Phd's) are nonetheless valuable and essential for the good of the CE officer corps. A master's program is not supposed to import knowledge as much as to teach thought processes. As such any challenging and legitimate program serves its purpose.

One that gets him his next job.

Facilities management is a good one, however, other engineering graduate programs should certainly not be discounted.

Unless one wants to be a specialist (i.e., structures, pavements, etc.) I don't think it really matters. The more management oriented - unless desiring a continued association with design - the better probably. Although subjects like political science and music are o.k., I don't think they would serve the 55XX all that well.

A technical degree in a civil engineering discipline such as pavements, structures, environmental, construction management.

One that you graduate from. Personally, I think a master's degree in your specialty is more important. I don't think there is one "appropriate" degree. The engineering management degree is most appropriate for the engineering officer. Aside from a few positions, civil engineering in the Air Force is a management job not an engineering one. Little true engineering is done.

Difficult to say, but I believe engineering management is the easiest to directly apply to most CE career paths. They will have difficulty applying a high degree of technical knowledge in AF CE.

Tough question. It would have to be something that covers human relations (with workshops), personnel issues (union, AFR 40-series, EEO, grievances, etc.), problem solving in real world situations, some statistical background, public relations, customer satisfaction, etc. Is there such a degree? I guess it would be a mixture between engineering management, business admin, human relations, and marketing.

A purely biased question based on individual perceptions. Personally, I feel a management degree is important because as we advance, we get away from "hard core" disciplines and more toward general management. The hard core egghead researchers would disagree with me.

I firmly believe a EM degree best prepares CE officers for future management assignments. Most of us with undergraduate technical degrees do not fully utilize them. Thus why spend an additional 2 years adding "salt to the wound."

I really think it depends on the civil engineering career path they choose to follow. Teaching technical topics at AFIT or the academy require degrees in particular engineering disciplines (EE, ME, CE, etc.) However, for most CE managers, I think the GEM program is outstanding.

The Air Force is not looking for design engineers in the 55XX career field; it's looking for managers with an engineering background. Therefore, an engineering management degree is ideal. Stick with GEM or GFM.

One that gets him/her promoted. I don't think I've ever had a need for technical depth so maybe a management degree is better for lifers. If the officer is getting out of the service; definitely a technical degree. There may be some jobs at the center and weapons lab that need technical researchers.

GEM is a good one (best for career officers), CE (general), MBA.

The one you currently offer in engineering management but without the thesis. We need the wide range of management expertise just by the scope of our mission - we don't get enough money, good people, or equipment so we need to be smarter in the management principles.

It's got to be the engineering management or an MBA. The technical stuff is too theory oriented to be of use to a designer. For someone at the field grade level, perhaps a political science or international politics degree would be useful. At the company grade and junior field grade level, you can't beat the GEM degree for practical knowledge.

I'm happy with my GEM degree and I recommend it to others, but I'm reluctant to say it is "the most appropriate" for CE officers. The career field needs some technical masters as well as us "loggies".

Depends on their job. R&D officers need a technical masters while other officers can benefit from the management masters.

In general, a management type master's degree seems best suited for an Air Force civil engineering officer. However, there are a number of jobs in the Air Force for which a civil engineering officer could be better prepared with a technical masters.

We're here to perform wartime duties. Degree should enhance an officers ability to do so - management over technical.

I feel that the engineering management program has helped in management work; however, it is just as important for a CE officer to be technical competent in his area of expertise. I think that a dual masters would be ideal for civil engineering officers.

Business management, but this assumes a lot of business background which engineers do not normally get; systems Management; public works, GEM at AFIT; and engineering management elsewhere.

GEM by far. It's tailored to our needs. It's Air Force specific. USAF CE officers don't need a masters in a CE technical field (with a few exceptions) ... current policy. We need management skills. Like we learn in the GEM program.

There is no one best master's degree for a USAF civil engineering officer. Academic background, experience, and ability to obtain an advanced degree are all influencing factors in the decision. Technical advanced degrees have more applicability earlier in a career; management degrees have more applicability mid-career to late career.

With the current career progression of an engineering officer, a master's in engineering management is most appropriate. Very seldom does an engineer do any design work beyond the first 4 years. Most of the jobs available to officers that are captains or higher involve management. While some jobs may still require technical skills for design reviews, a PE license would cover these skills.

If I could have, I would have gone for the civil engineer master's program.

For an Air Force CE officer any kind of management degree is good. Technical aspects play a small role past the rank of captain.

None at all. Another 15 months on the job would be more beneficial.

I strongly believe the engineering management degree is most appropriate. Since most design work is by civil service "technocrats" and civil engineering officers above the rank of captain almost exclusively serve in management positions.

I feel that a management-oriented master's degree is most valuable, since CE officers will be managers and leaders soon after entering active duty. Technically oriented masters programs might be fine for specialists in private industry who plan to design projects until retirement, but in my opinion, technical courses serve little use for AF CE officers.

For a manager, the GEM degree; for a theoretician, a hard engineering degree.

None is <u>most</u> appropriate, a mix of master's degrees is best. Some in management, others in engineering and even some social science degrees help balance the field. A single degree for everyone would be a disaster.

I don't think there is a definitive answer. I think it revolves around the needs of the AF and the motivations of the individuals. For me, the engineering management degree was great. However, for the more technically

oriented person, they might get more out of a technical degree.

Engineering management but more courses like "supervision", leadership, people management, etc. are required. Financial management is important.

24. What is the best way to prepare CE officers to be effective managers?

Classroom instruction (not necessarily books but practical training) and experience.

Education - then give them as much experience/ responsibility you can at an early age.

Put them in management positions and let them learn. This, combined with a managerial degree (where management theories are taught), is probably the best combination. Again, it depends on the individual.

Education combined with wide ranging experience in different jobs (CE and otherwise) and exposure to many different leaders and supervisors (BCEs, Wing/CCs). You see leaders who do it well and badly.

Let them manage - you only learn it by doing it, do not listen to theory in the class.

Provide more opportunities for junior captains and lieutenants to have positions of decision making capability in the CE operations branch. Have one or two superintendent positions be officer positions, or rotate R&L jobs more frequently at squadron level.

Through increased education and the practical experience to apply what they've learned.

More short courses. More operations experience early in their careers. Management of projects (cradle to grave).

Let them, make them manage. Senior officers should be more involved in guiding junior officers instead of managing for them. Make the officers branch chiefs - let the civilians serve a support role.

GEM followed by hands on experience. However, management is just a subcategory under leadership. I find when you have more people working for you (example - chief of ops), leadership becomes more critical than management skills. The managers work for you and you have to get everyone motivated toward the same goal, CE's mission. I suggest more emphasis on leadership and less on management. (Let the civilians manage the resources and let the officers lead the troops and the managers).

A combination of education and on-the-job experience. On-the-job experience, in the final analysis, is probably the most critical ingredient, which is fortunate since education can't reach all officers. However, education is highly desirable because it expedites and helps the development of future senior leaders less traumatic and difficult for the individual. In other words, education "opens the eyes" and gives young officers a taste of what the art of management is before he comes "under fire" on the job. I was fortunate to have received my AFIT engineering management degree right out of ROTC.

Drop them in the job and let them make mistakes - a "trial by fire."

I believe there is no real "best way" besides being a practicing manager first hand.

The best way is to "learn by doing," (i.e., actually serving in managerial positions). Courses and seminars in management are helpful, but all the management theories in the world won't help solve a tough personnel or resources problem in the day-to-day workplace. AFIT might help by organizing management or leadership "laboratories," in which students must deal with realistic management dilemmas.

We should teach them to be better leaders by giving them more experience in the field with NCOs and airmen. Our officers get plenty of on the job experience in becoming effective managers.

OJT with an experienced engineering manager. The theory that is offered at AFIT is a good foundation but until you staff AFIT with capable experienced engineering managers it will be unable to offer more than theory. A good addition to the AFIT education would be a year as a special assistant to a senior engineering manager either within the Air Force or as education with industry.

Train their supervisors in a way that allows them to understand and guide the professional development and managerial skills of CE officers under their charge.

Short courses at AFIT (2 or 3 weeks) that address specific areas of the CE field.

GEM is a good start. SOS in residence is another good source. OJT has most practical value.

This is like how does one make a good leader. What's effective and to who? An effective manager to the 0-6 is a "yes" man. To the worker bee he is somebody who goes to bat for him. So if you want a career officer, don't teach him anything. If you want an "effective" manager, teach him to be a leader and the rest will fall into place.

Manager is a subset of leadership and should be taught that way. We need to insure all CE officers attend SOS in residence and offer a basic 3-6 month introductory course for all new lieutenants teaching about CE, contingency environment and have leadership exercises. Then when 55XX is a captain, have them get a masters in a related field.

Send them overseas to an operational base for one to two years, and put them in pressure situations. Let them learn the bread and butter of CE. School won't teach you everything.

Through depth and variety of experience. The benefits of a master's degree are overstated.

Give them as much responsibility as soon as possible. Try to get young officers exposed to management at base level. Let officers attend meetings and be involved in the decision making process instead of hiding them at a design table or programming desk. Rotating young officers into the operations branch is one way. Letting officers work with other branch chiefs will also help. Exposure to the system is the key, and delegating responsibilities is a method. However, always keep in mind you have to develop leadership skills as well as management skills.

Experience in diverse functions of their unit - DEE, DEM, etc. Exposure to DEM and DEI, with a reasonable grasp of functions, requirements, capabilities exposure to squadron commander responsibilities, counseling requirements, etc. Must be offered an opportunity to observe, and to manage on a growing scale within the organizations.

Grow 'em to be effective managers. Get them out of engineering design as soon as possible and put them to work managing others. As a minimum get 'em out and about to observe what's going on a daily basis at a wing/within the group/in the squadron's O&M function. SAC's readiness and ownership oriented management (ROOM) concept for CE's helps do this.

In general, CE officers need more interpersonal skills. These can be best learned through a mentor. Young CE officers should spend more time shadowing/observing senior CE officers. In addition, within the framework of the Executive Engineering Management Symposia, senior CE officers should discuss the nuts and bolts of their management styles - when to write a note - when to have a meeting - when to meet one-on-one. They could also relate actual experiences they've had dealing with people where they've - learned something - been particularly effective - or been particularly ineffective. We can learn from their examples.

Base level assignment within operations: Chief of Readiness, Chief of Logistics, Chief of Requirements, Chief of Operations.

Have an initial training period for each officer when coming into the career field (similar to Army). This way all officers have equal training and start with the same direction. Other follow-on courses for all officers should follow. The system (now) does not consider that some BCEs do not want you to be away from the job. MS degrees should be competitive.

Better to prepare them to be leaders, but GEM program is a fine way. Forcing students to do a thesis requires them to look at the AF mission and how CE fits in to the school.

The best way is through education in managerial techniques and lessons (lessons learned via case studies). Additionally, continuing education programs allow one to evaluate themselves and their effectiveness. However, all this knowledge can never guarantee effectiveness.

Put 'em in the hot seat, let 'em fry a little, pull 'em out and cool 'em off, then send 'em to school to rest and reflect on the heat.

One thing that severely hurts a CE officer at least for the first 10 years is lack of knowledge about all aspects of CE responsibilities. Management skills are fine, but a complete understanding of roles, missions, rules, regulations, congressional laws, etc. would better prepare CE officers to tackle their individual jobs. Therefore, I feel the best way to prepare CE officers is through a comprehensive technical training program like other career fields have.

Teach organizational and management theory. Teach problem solving techniques. Teach financial, contract management and linear programming methods. Teach in areas which are of special importance to most BCEs - i.e., environmental

I believe the GEM program should be expanded to 2 1/4 years with a mandatory education with industry (1 year) tour. Let the officer observe and participate in some of the fortune 500 companies management structure. Successful companies generally breed successful, effective leaders. What better way to emulate.

Shadow program with senior officers. Teaching them to deal with people and not just resources.

Move them around into various management positions. Give them time to learn then press for performance. Encourage/support the thinking process.

Try to relate "realistic" situations as appropriate in selected courses to reinforce the theory being taught.

The objective should be to provide the tools necessary to be an effective manager as well as case studies detailing solutions to common problems the CE officer may encounter. I do not believe that an effective manager can be "prepared." A manager can only be shown how to use the tools and techniques available. An "effective manager" like and effective "leader" is someone that evolves not someone who is made.

Nurture leadership/followership. Teach them how to identify/measure pulse points of an organization. Speaking/writing effectiveness.

Let them "manage" their own base-level jobs without having supervisors "micro-manage" them.

Orient GEM to "corporate" engineering and construction management practices: contracting techniques, construction scheduling, design scheduling, performance evaluation theory and techniques, programming theory and practice, parametric cost estimating, engineering and construction computer applications.

Early supervisory experience. Early training programs. A work environment where new ideas are encouraged and errors are of secondary importance.

Good career management ... jobs that build on one another coupled with educational opportunities such as PME in residence, AFIT short courses, and master's degree.

Teach them the skills to be 1) good decision makers and 2) leaders, but also teach that we're in a customer service business (in peacetime). It's our job to make the people on the base happy. Public relations plays a very important role in how the base customers perceive our ability to do our job. CE officers need to learn more about selling a good image and educating our CE troops about being customer-service orientated.

A mix of professional (engineering) education, military education and the right assignments with the responsibility that goes with tough jobs.

Experience. Then periodic courses to broaden thinking. The new OER system is right on, performance should be the key not whether or not a person has all the "squares filled" including a master's degree. The new SAC ROOM (Readiness and Ownership Oriented Management) is an attempt to bring officers into supervisory/management roles earlier. It should increase experience. It is certainly working at Wurtsmith.

Tough question and there is no "one best way". Need to encourage open communication between senior officers and lieutenants. At the club on Friday afternoon is a good time for me. Too often lieutenants are not abreast of all that's happening in a large CE squadron.

This degree helps, but a more continuous spectrum of management related jobs in CE would be better. A program of progression through these jobs with evaluation to determine readiness to "progress" to the next level would help. I'm not sure the management jobs in squadrons at base level are there.

Start them early (1st Lt as a minimum) - give them basic management training (both technical and people oriented) and get them in a meaningful/responsible management job. But, don't fail to provide someone to advise them, someone with experience. Like a child learning to swim, you have to let them do it, but an instructor can be helpful at times.

19. What is the most appropriate master's degree for a civil engineering officer?

No "one best" degree. We need a mix of "technical" and "management" master's degree holders. For each individual, the most appropriate degree is a function of his/her talents, abilities, interests, and motivation. In general, an engineering management degree is most beneficial in terms of long term utility to the CE officer as a manager/leader. However, the master's degree field is not of primary importance in long term effectiveness as an engineering manager. Many PhDs in technical specialties are outstanding senior managers. Conversely, some people with a masters in engineering management never achieve success as a senior manager.

My opinion would a MBA. AF needs very few technical master's degree or PhDs in civil engineering. Unless one's into R&D the business side would be more beneficial - probably better in R&D. Also, since we (AF) contract everything out.

Master's degree through a civilian institute. Degree is "worth" more from a civilian institute than from AFIT.

Some form of management with emphasis on engineering, especially now with the new OER system.

That depends on where in the career field the CE officer works. For example, at AF Weapons Lab at Kirtland AFB NM or Engr and Svcs Center, most appropriate masters would be in research-related specialty. At base level CE, engineering management would be appropriate.

MBA.

There is no single most appropriate degree; just as there are benefits to the organization as a whole by receiving graduates of a variety of schools, there are benefits to be gained from a staff of varying educational disciplines. Some I believe are appropriate: business management, economics, public administration, all engineering disciplines, computer science/ops analysis, law, environmental science, construction science, geology, and industrial management.

Engineering Management.

Whatever the officer feels he needs the education emphasis in to make him competitive for what he wants to do in the Air Force. I took a technical slant and got my management emphasis in PME courses - SOS and ACSC. I will never regret my choice. Others desiring pure management would seek an engineering management degree. Another aspect is that many would take whatever the Air Force provides - education is of benefit no matter what it is in.

General management or administration.

Any management degree, especially MBA. That's what we do. The farther you promote the less engineering you'll do and the more managing.

Systems management or a pure business management.

Construction management, engineering management, or business administration.

Public works/engineering management.

I don't think any particular master's degree would be the most appropriate for a CE officer. Choosing a master's degree should be left with an officers preference and his/her educational goals. However, CE officers need more hands-on experience to prepare for their war-time engineering mission. There should be core engineering courses which will enhance basic engineering skills in construction and O&M.

Industrial management.

I have a masters in mechanical engineering and am currently enrolled in an MBA (3/4 done). I have found the MBA to be of more value. My understanding of business and how the world works has proved more valuable. A technical degree is only of value if one is in a research/development job. However, most engineers are employed at base level where management skills are required.

For an Air Force CE officer, a master's degree in engineering management is probably most appropriate. The Air Force says they want technical people but in reality they want managers. A technical masters, while helpful, probably wouldn't contribute as much to job performance.

For the industrial engineer, either a GEM or MBA (qualitative analysis) or MSIE (QA, computer ops, engineering management). I don't think it matters.

I don't think there's a "most appropriate". However, I do believe engineers should be more technical than they are now. By understanding the technical aspects of a utility system and facility construction an engineering officer is better able to manage the resources required to operate and maintain real property.

What they're interested in, if needed in the career field. Not sure GEM course material is appropriate for CE officer.

The degree that he wants for himself. Management can be learned on the job and with PME courses - a degree taken to fulfill a square ceases to become a learning experience but a must do.

It depends on whether the person is an architect, mechanical engineer, electrical engineer, etc. The appropriate master's degree should enhance the person's technical background and prepare him/her for the future "high-tech" challenges of the Air Force.

Engineering management sounds reasonable. However, we have to ensure the program is tailored to the needs of the civil engineering community. I think there should be more emphasis in decision-making, problem solving; less on statistical analysis. Otherwise the degree won't be of any use.

Engineering management. Degree should include not only management options, but also courses in structures and soil engineering.

One that includes management, systems, and scheduling from a "big picture" perspective. Pure engineering will not provide all the tools needed to manage a DCS, MCP's, AFRCE's, or joint operations.

Depends ... we need technical specialists too. The "best" degree for Air Force civil engineering is a combination of technical graduate degrees to meet our needs of designing, constructing, and maintaining an ever growing sophisticated facility support system for our weapon systems and management degrees for the field engineers.

Probably engineering management, but practical application experience that can be gained through a building construction degree like Texas A&M offers, would be top-notch.

Probably should be a combination of engineering management and systems management. The systems degree allows the use of business theory and practical analysis

of todays management problems. Also, the individual is not tied to a technical management perspective, but one that is broader based.

Civil engineering management.

It depends on when the master's degree is taken during the officers career and for what purpose. I think the AFIT GEM degree is great as a resource to research CE management problems but does not benefit the student. A student needs to associate not only with the CE technical areas but to associate with other line officers. Also, if an officer is early in his career I highly recommend a master's program from a civilian university in technical engineering program.

Business management, architectural/structural/civil/ mechanical/electric/etc., psychology, personnel management.

No difference. Degree is a square filler for promotion.

Engineering management or IE. I think I am far better prepared to deal with people to be an effective manager due to my undergraduate and graduate IE degrees. Technical master's degrees should only be considered for specific technical jobs such as R&D and space systems management. The majority of CE jobs are highly people intensive rather than technical. To be an effective CE officer you need a technical background and the ability to effectively lead and manage people.

Material and resource management.

I believe a technical (vs management) degree is more appropriate since we are still responsible for ensuring designs are technically accurate regardless of how they're accomplished and also an understanding of the facility designs/construction and state-of-the-art understanding of engineering is also critical for bare base operations. Engineering management is important, but I feel that can be learned through experience and AFIT School of Civil Engineering short courses.

Specialization in engineering discipline; public administration.

There is no most appropriate. There is a need for a wide spectrum of degrees from soils to structure to contract management.

There is no single "best" option. The career field needs a wide variety of expertise from pavements,

structures, environmental, soils, electrical power, architectural, industrial, etc.

GEM

Engineering management with emphasis on managing resources (i.e., people, money, assets) versus managing technology.

Industrial and systems engineering

It may be that engineering management is the most appropriate since little work is done in specialized engineering disciplines at the management level. My master's is in industrial engineering which resembles engineering management more than the other disciplines, and I feel I am better prepared to handle my responsibilities.

Public administration or business administration.

I don't believe there is an "appropriate" master's degree for civil engineering officers. However, I do believe a master's degree in a technical area will certainly enhance an officers selection for a job in a research and development program or as an instructor at AFIT or the Academy.

There is no "most" appropriate degree. However, I would say that most BCE's would benefit from some graduate level managerial courses. The two most appropriate areas of study to me would be technical or managerial.

None is "most appropriate". Too many factors at play with individuals background, ability, interest, and personal goals. I think the degree should be technical in nature with a variety of management/business courses as required electives. All management MS degrees provide an easy way to fill the degree square and don't provide as big a payback to the individual.

Who can say? Civil engineering officers today are involved in research and development, operational test and evaluation, facility maintenance, teaching, etc. The most appropriate master's degree should consider the individual as well as the career field.

20. What is the best method of teaching students how to do research?

First we must define what is meant by "research." If we are talking about original or basic research, then the best method is rigorous, closely supervised academic research, such as would be required in full scope thesis preparation. If by research we mean the investigation of a problem, consideration of alternatives, and determination of a solution, then emphasis should be placed on special projects and investigative papers, without the full scope and rigor of a thesis. The seminar and case study approach can also be used to provide exposure to practical, real-world problem solving situations.

Have them do research, come up with problems, collect and analyze data, and give answers, trends, and recommendations.

Instructor/professor working one on one with individual to "coach" individual in how to research (i.e., what sources, type of testing, etc.).

Practice in the lab or doing actual research.

There is no best method. Students learn to do research by doing research, preferably working with someone who is talented at doing research. All students are different. What works for some wouldn't work for others.

Take a research course and do a research paper afterwards.

Provide examples and then do problems or assignments based on examples.

Preparation of a thesis.

More important I think the question should be to what degree do students (55XX) need to do research? I believe, with the exception of those who would pursue a PhD later, research to the level of a thesis takes time which could be better used taking additional coursework.

Gaining experience on a true-to-life problem/project is the only effective way to learn research work.

Depends on what type research. If for R&D applications, then a large scale but focused, thesis project. If for

day-to-day applications (staff studies, etc.) then individual papers for each class in master's program.

We need to decide what we are trying to do. Are we concerned with R&D and studies - not as a BCE, Ops Chief, MAJCOM action officer, etc. So why spend all that time on research. Maybe 10% of the officers do research. We need to focus on teaching officers to think on their own. Get away from "rote" memory. My current postgrad work in human resource development is very pedagogy oriented not androgogy like AFIT. This course of study is also very experimentally oriented (i.e., for my client-consultant class I had to go find a client to do actual consulting, for training design I had to design a training program, etc.).

The goal of research is not the research itself, but the presentation of that research. I feel I received more benefit from my ACSC research project in the presentation of it and logical relationships of data than I would have from a civilian thesis.

Should not be an engineering effort to correct the sins of the world. Let project research be stressed in ACSC and AWC.

Brief classroom instruction (~10 hours), to teach methods of research, then learn by doing.

Case studies, short field exercises, limited scope thesis work.

Get them involved in real world problem with the Air Force personnel actually working the problem. We should put more emphasis on "the problem solving" skill rather than basic research. The Air Force doesn't need researchers it needs problem solvers. I think research minded students should go for PhD.

I'm not convinced you can teach a student how to do research. While you can provide suggestions, procedures, and examples, doing research is something the individual wants to do. Self motivation, genuine interest in the topic, and hands-on experience do more for successful research than a text ever could. Having an advisor is beneficial to ensure researcher stays on track.

I don't know what the best method for teaching students how to research. I can say that in the Air Force, research is more for quick problem solving than for in-depth analyses or studies. We pay others to do that.

No doubt a thesis. The hardest part of research is the initial definition of the problem. Most people will initially want to include more in a research study than they're capable or have an idea of what they want to study but no idea as how to define it. A thesis solves all these problems by forcing the process.

There is not one best method. Different problems require different methods. One underlying requirement, though, should be that the research should tackle real life problems that confront, or will confront, Air Force civil engineering and services. This crap of sending out meaningless, half-baked surveys (like this one) and calling it research has got to stop.

Why do we have to teach students how to do research? Civil engineers are not normally into R&D. I think we should teach civil engineers how to become efficient decision makers, not how to conduct research.

Begin with small assignments requiring research and lead up to larger assignments (thesis/final report). Allows student to get a feel for work required and how he should budget his time accordingly.

Back to the basics. Start small, work up to standard research project. Push original thought, open-ended questions/projects, contrast and compare.

Short problem solving exercises - with a thesis, there is a tendency to get "wound around" the subject to the degree the topic becomes more important than the learning experience.

In general, I am opposed to research. Too much emphasis is placed on report formats, admin requirements, etc. What AF CE officers need in my opinion is on-the-job project experience. Instead of doing research, they should spend some time on construction jobs to "observe" how they are being managed. Enough research experience is gained during the undergraduate years and through PME.

A step-by-step approach using varying avenues of resources. An outline should be generated and initial ideas generated from the literature of the thesis topic before more detailed research is accomplished. The research topic should result in an original conclusion based on the facts and an intelligent interpretation of their ambiguities. A class could be designed to develop a small scale thesis to be monitored and completed within the course of a single term prior to work on the master's/PhD thesis.

A "practice" project smaller in scope that emphasizes the process more than the results using advisors in the areas of research and writing as well as the specialty.

Is research necessary? If so contract it out. That's what the Air Force did for the new OES system.

Instruction on the research, analysis, documentation process followed by research assignment. However, I believe 2 smaller projects would be more beneficial than a thesis.

In engineering management, where a student will go back to Air Force CE, a research report may gain them some short term knowledge in an area of choice, but in my opinion, quickly becomes outdated knowledge, as our business changes. In a technical degree, a research report is probably more appropriate. To teach research? Start with smaller papers in initial classes and learn the basics. Give a student sufficient time, when they can devote their efforts to a large effort, unimpeded with a full course work of competing classes. Don't make procrastination too easy by including occasional reviews of progress by an instructor.

Introduce the subject being researched through case studies and examples that relate the subject to real life situations. Then, it's time to bust the books and late hours at the library. To research a subject effectively, I must be somewhat familiar and interested in the topic. It also helps to know that my long hours are being spent on something that is worthwhile ... the purpose of the research needs to be understood.

To work along side professional researchers at WPAFB or bring in researchers from local industries.

Trial and error.

It is, obviously, to do a thesis or at least a research paper on a realistic problem. Adequate lab and computer resources must be provided the student so all aspects of the required research can be completed.

I don't agree with the premise that we must have engineers who are research experts. They must know how to think and analyze situations to cope with most of our engineering jobs. Research and the sterile laboratory atmosphere has little place in our business. Experience and experimenting in the field is the best teacher.

Teach the thought process (what are the correct questions to ask); teach where sources of information

can be found (library, DTIC, etc); require them to write a test plan.

Assuming research is important for managers - which I doubt - then a term paper (like required in AWC) is a useful tool. Life-or-death proposition of full-blown thesis improves the breadth of research but not necessarily the quality.

You don't need to. Students get enough in undergraduate school and PME.

Once a topic is assigned, advise the students of the "special interest" areas which could impact their grades if not thoroughly researched.

To me, the method is secondary to the interest/ incentive/desire to learn about the subject.

Teach application of the scientific method to problem solving while maintaining an optimum balance of "real world," hands-on experience with classroom/lab training. Maintenance of the above would be necessary through application of continuing education and experience.

Solving real-world problems is the key. While research for the sake of research will give some success, students need to feel like they are accomplishing something rather than just filling an academic square.

Usually with increasing project scope and a fairly good outline and guidance of project requirements for a complex problem or study.

Promote individual or small group (2-3) effort following one or two structured case examples in classroom environment.

Starting with students as research assistants and later assigning them more complex projects as their analytical skills improve.

21. What is the best way to prepare CE officers to be effective managers?

Let them manage. Civil engineering squadrons at base level are too civilian oriented. At my particular base there are only 2 positions with any management opportunity for 7 company grade engineering officers. The only military manager in DEE is the Assistant Chief of Construction management and our 1 major assigned is Deputy to a civilian Chief of Operations. This is no way to develop officers.

Learn by example and by doing. The examples must show the good and bad ways with explanations. Most of the time one learns by osmosis and the school of hard knocks. These are not the best ways to learn.

Practical experience. We must offer our younger officers opportunities to learn and to make mistakes. To often, we are governed by an environment where there is great fear of being wrong. That is not realistic. Let's put our people in learning situations, not hide them because they're young and/or inexperienced.

Broad exposure to the "big picture." Look at all aspects of the system that impact on CE's ability to operate (i.e., supply, budget).

PME and masters in management engineering.

Increase incrementally the amount of managerial responsibilities for the CE officer as he develops as an officer.

Field experience tempered with management academia introduced in a timely fashion. Effective management can only be obtained through practical experience with an appropriate mixture of book learning techniques. I believe I have learned as much through books/papers combined with my practical experience. In other words, a master's degree is overplayed while continuing education at all stages of development is a must.

Case studies - if experience in CE is lacking.

Education coupled with experience is the key. While experience alone will eventually get you there, education speeds up the process considerably. The only way to make an effective manager in a reasonable time frame is by a combination of education and experience.

Get them a broad base of experience, especially in design and construction management. I have never worked for an ineffective manager. Occasionally command interest, funding, etc. forces a less than optimal engineering solution but that is more a system problem than a managerial problem.

Put them in positions where they have the opportunity to manage, that is assuming they have some exposure to certain management theories through their formal education or PME.

Exposure to the various management styles (i.e., strength and weaknesses) and the best style to rise given the personalities of their subordinates. Give scenarios and have students provide solutions to various management problems.

Give them the core business administration courses in funds, organization, and personnel management.

Mentorship. I believe this is the best way but in my brief time in CE I have not encountered anyone who was either willing or able to be my mentor.

Assignments should be "grooming" in nature, for management positions. Career paths should be structured with the individual being able to choose his career path only. This way, jobs will not be the problem, rather job performance.

Broad education; prepare for anything - both technical and managerial; need to be "fearless" in the facility maintenance/engineering business.

Classroom instruction and seminar interaction with experienced managers and case histories; then practical experience followed at intervals by refresher training. Let's not pretend we all become managers - only one-fourth of my career has involved managing other people.

Educate, train, and challenge them in positions that blend their engineering degrees with the management of resources to meet the needs of the Air Force. Organizationally, we need less junior officers in the engineering and environmental planning branch, and more in the operations branch. Educationally, we need more engineering managers and less engineering "researchists" for the day-to-day CE business.

Education and OJT. But management is only part of the job. AF officers must manage, lead and be technically sound. Manage: projects and budgets during routine operations; Lead: people - motivate and direct especially in crisis situations; Technology: expertise to evaluate alternative methods, work at AF labs, develop new technologies to solve AF problems, teach at AFIT or USAFA, obtain professional registration.

Provide situation-role playing with immediate feedback. Practice.

Get them technical experience in their first 2-5 years (at least 3 years of engineering, not management). Then get the good ones to graduate school. After that, a variety of jobs in O&M, engineering and readiness at base and in several different positions at headquarters or special organizations. The experience out there coupled with the CE short courses provides a good diet of learning to deal with the challenges of today's engineering environment.

Strongly encourage a master's program in an area of engineering management or public administration.

More education with industry.

Case studies, lots of group discussion on real-life experiences. All the tools of management theories are worthless if they can't be related to how it is in the "real world."

Putting them in jobs that let them and reward them for managing.

Get the lieutenants out of the drafting rooms and planning departments and make them work for a MSgt, SMSgt, or Chief in production control or the shops for about 6 months to a year. Remote tours early in a career also have great benefit.

Coursework on management theory and AF management systems is useful. However, there is no better preparation than actual experience. The 55XX career field needs to provide our 01-03 greater and earlier exposure to management/leadership situations.

Need to watch out for them early in their career. Have CE officers work for military managers rather than a civilian who may not have the full scope of military management and responsibilities. The Air Force CE officers too often eat their young.

The best way to learn is by doing. Use CE case studies. Provide students with varying case studies pertaining to all aspects of CE career field. Have the student solve the problems with either written or verbal responses, or both.

Anyone can be a manager, but to tap the full potential of someone, you need to be a leader. The Air Force needs to stress leadership - not management. Need to develop a CE school for 2nd Lts, similar to what the Navy has at Port Hueneme, CA.

There should be a greater opportunity for engineering officers to be involved in the operations portion of a CE squadron as early as possible. For example, at the time I took a career broadening assignment to Acquisition Logistics (1986; AFSC 6624), the Air Force was considering putting junior officers into the fire protection and operations superintendents positions. This would alleviate a problem of having officers who've sat behind an engineering desk for 3/4 years and then be thrust into a management position of enlisted members, not having had any formal management/training or supervisory leadership responsibilities.

Public speaking, writing, etc. Anything that will help deal with the bureaucracy. Supervision/leadership. We need to emphasize people.

No best way. It takes many qualities to manage. Depending on the individual, some need to have certain qualities stressed the most, while others, deficient in other qualities, need to have those stressed more.

Responsibility as quickly as possible. Force them to make decisions to let them see how they impact CE operations. Practice in this area combined with job experience and appropriate classroom knowledge will help prepare CE officers for their roles as managers/leaders.

Coursework, theory, scenario discussions, experience dealing with people. Selected courses in psychology and sociology. Need to be able to manage people as well as programs.

Give them the necessary technical and scientific background. Then, through a graduated series of leadership responsibilities, "intern" them into effective managers. I think the new OES, especially the performance feedback portion, could be an excellent vehicle for this.

Manage people. Learn proven ways of managing people and resources.

Ensure a solid technical background and exposure to management theory and techniques, after that it's a matter of doing.

Require BCE course as lead in TDY "tech school". Increase management skills continuing education course work or allow integration into successful civilian management training programs. Businesses make or lose money based upon the success of management; so do we. Why not find out what the successful ones are doing by increased EWI programs or by allowing CE management to attend some of their executive development programs.

Encourage young men and women who want to be engineering managers to go to OTS, ROTC, and AFA. As it is, by stressing high GPAs for acceptance to OTS and for ROTC scholarships the Air Force is getting the best technical minds out there. However, many may not be interested in being managers as soon as they enter the Air Force. We need to tell them - before they commit themselves - what "engineers" in the Air Force really do. They manage. The Air Force wants their engineering background, not necessarily their expertise. The best thing the Air Force can do is to encourage and target those who want to be engineering managers. Most engineers will become managers. Some gradually, others from the start. In the Air Force, it's typically from the start. Many of the technically sharp officers coming into the Air Force seem to be getting out after their original commitment because they want to be engineers, not managers. Let's be honest with them up front.

Field experience coupled with classroom education.

A master's in a management related field combined with a variety of CE jobs is best. Rotation of officers throughout a CE squadron gives one a better understanding of the organization.

Again "learn by doing". Set up situations similar (in concept) to the leadership reaction course at OTS and give everyone their turn in the manager's role.

Continuing education through seminars, workshops and further higher education.

To be effective, we need to understand our business, which comes mostly through experience. Secondly, we need to be able to solve problems, and to think at a fairly high level. That's where the master's degree comes in, and the type of master's degree is not critical, just so its challenging. Finally, we need to know how to manage resources and people. This one is best handled through short, highly focused courses.

Case study format works and is excellent (probably the best except to learn by doing and from your own mistakes). Also learn from others' experience (both seniors and peers). Need to educate senior CE officers on mentorship.

Short initial and refresher courses to set the stage and keep attention, followed by application under the eye of a competent manager. We need to do more like the Army in this area to prepare our Lts and Capts for leadership and management.

Put them through an experimental course of study, force them to work key managerial problems. Group experimental learning ought to be the main part of the class. Group tests, group projects, etc. Do away with a thesis program. It does no one any good.

As early in every career as possible, put officers in supervisory roles. Both office and field present leadership challenges, and academic knowledge reinforces those experiences.

Provide courses on group dynamics, human behavior, and management using case studies (not necessarily Air Force case studies). Case studies provide real world examples and enable 20-20 hindsight.

Take courses that broaden their outlook from engineering: communication skills (speaking, writing); motivational skills (inter-personal communication, argument, persuasion, psychology, protocol); time management; law and ethics; production processes (planning, organizing, controlling, resource management); computers.

Gradually increase management responsibilities throughout their careers, send people who show a future to schools and seminars as they become available, and purge non-effective managers from management positions. Everybody is not meant to be able to do everything.

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ABSTRACT

This research study was undertaken to determine how well the Air Force Institute of Technology's (AFIT) Graduate Engineering Management (GEM) program accomplishes its task of preparing civil engineering officers to become effective engineering managers. The primary purpose of this research project was to determine if there was any discernible differences in performance between GEM graduates and non-GEM graduates (civil engineering officers who have received their masters degree by any method other than the GEM program). The secondary objective was to determine if completing the thesis prepares GEM graduates to be better problem solvers.

The data was collected by mailing separate surveys to three groups of active duty Air Force civil engineering officers: 1) those who supervise both a GEM and non-GEM graduate; 2) those who have completed the GEM program; and 3) those who have completed their masters degree by any method other than the GEM program.

The responses to the survey questions were rated on a seven-point Likert scale. Areas of significant difference between the group ratings were examined using the t-test.

Civil engineering supervisors indicated GEM graduates as a group displayed no discernible differences in job performance from non-GEM graduates. Second, supervisors' assessments of problem solving ability for the GEM graduates were significantly higher than non-GEM graduates.

Fifty-seven percent of the GEM graduates and fifty-two percent of the non-GEM graduates agree the thesis is not the best method for learning problem solving skills. In addition, 73 percent of the supervisors, 52 percent of the GEM graduates, and 61.7 percent of the non-GEM graduates agree that AFIT should discontinue the thesis or make it optional.